THE GEOLOGY OF THE DUNDAS - PIEMAN RIVER AREA

by

GEOFFREY D. LOFTUS-HILLS B.Sc.

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CONTENTS

			Page
1	Introduction		1
	1.1	Scope of the investigation	1
	1.2	Procedure	2
	1.3	Access	3
	1.4	Acknowledgements	6
2	Geography		8
	2.1	Topography and drainage	8
	2.2	Climate	9
	2.3	Vegetation	10
3	Exploration and development		12
4	Stratigraphy		15
	4.1	Carbine Group - Crimson Creek Formation - Dundas Group	18
	4.2	Success Creek Group - Crimson Creek Formation - Huskisson Group	36
	4.3	Rosebery - Renison Bell Synclinorium	40
	4.31	Rosebery Group	43
	4.32	Crimson Creek Formation	55
5	Igneous activity		69
6	Conditions of deposition		73
7	Deformation and metamorphism		77
8	Correlations		79

9. Structure 82

10. Mineralization 86

11. Geomorphology 89

12. Geological History 91

13. Appendices 92

13.1 Rock Specimen Index and Locality Maps. 92

13.2 Departmental slides. 107

14. References. 114

FIGURES

The following figures are contained under separate cover.

4

8

9

11

11a

13

17

18

19

20

21

ABSTRACT

Petrographic examination reveals that the Crimson Creek Formation and the Dundas Group are typical eugeosynclinal suites, although they represent different stages in the evolution of the Dundas Trough. They are only very mildly metamorphosed.

Correlation between the Dundas Group and the Huskisson Group is not well defined, even on palaeontological grounds.

The Rosebery Group to the west of Rosebery is proved to dip normally to the west, which complicates the structural interpretation. Part of it is tentatively correlated with the Success Creek and Carbine Groups, and the inferred structure between Rosebery and Renison Bell is thus a synclinorium, which is axially faulted.

Lead, zinc and tin mineralization in the area follows NNW Tabberabberan fold crestal trace directions, and probably represents filling of tension faults caused by local flexing of the anticlines. Evidence for regional control of mineralization is not forthcoming.

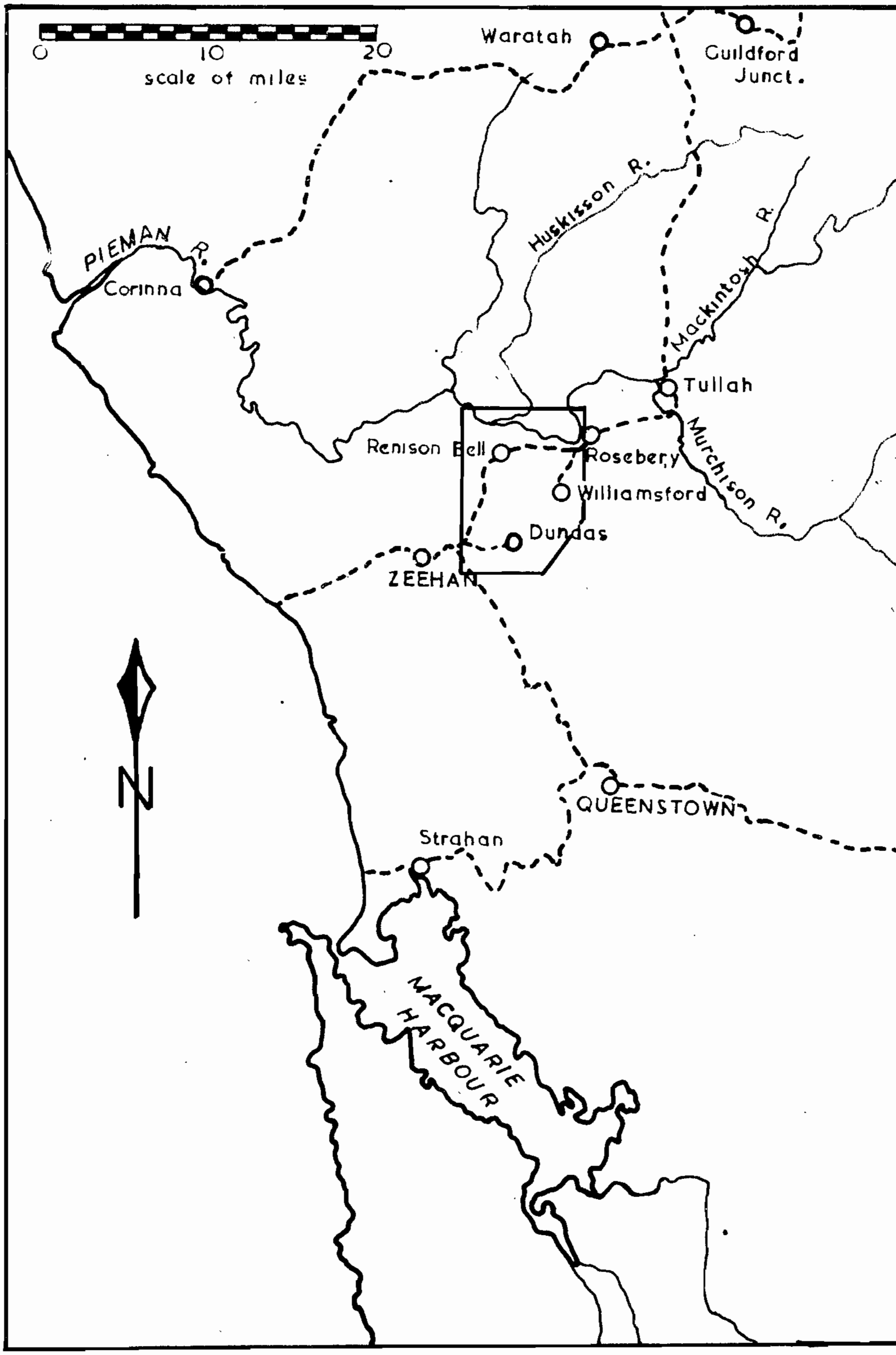

FIGURE 1: LOCATION OF THE AREA.

1 INTRODUCTION

1.1 Scope of the investigation

This thesis deals with certain restricted aspects of the geology, mineralization and geomorphology of an area of almost 60 square miles on the West Coast of Tasmania, bounded by the old Dundas mining field, Renison Bell, the Huskisson River, Rosebery, and Williamsford (Fig. 1).

The older rocks of the area consists of

(a) an inlier of Older Proterozoic schist;

(b) possible correlates of the Oonah Quartzite and Slate (Upper Proterozoic to Lower Cambrian);

(c) the type section of the overlying unfossiliferous Crimson Creek Formation;

(d) the edge of the arc of unfossiliferous Cambrian Mount Read Volcanics; and

(e) the type section of the lower Middle Cambrian to middle Upper Cambrian Dundas Group.

Younger Palaeozoic rocks occur peripheral to the area, but they are of incidental importance in the present context.

There were three main phases of the investigation.

(1) A study of the stratigraphy of the Dundas Group, and of its correlate the Huskisson Group, was built around a petrographic examination of a suite of specimens from a section through the Dundas Group. The results were then utilized, for comparative purposes, in:

(2) A detailed field and laboratory examination of the petrology, stratigraphy and structure of the succession (including (b), (c) and (d) above) across the synclinorium between Rosebery and Renison Bell.

(3) A general analysis of the mineralization across the area.

As part of these investigations, studies were made of

(a) the regional structure of the area; and

(b) the geomorphology of the Rosebery-Renison Bell sector, and in particular its glaciation.

1.2 Procedure

Between February and December, 1963, eleven weeks of field work were completed - 3½ weeks in examination of the Dundas Group; 3 weeks in examining the mines of the area; and 4½ weeks in mapping the Rosebery-Renison Bell succession.

Information was first recorded onto either aerial photographs on a scale of approximately 1":20 chains, or larger scale sketches copied from dyelines produced by the Department of Lands and Surveys. The area was covered by dyelines of parts of sheets Zeehan B, Zeehan D, and Murchison A. Information was later plotted onto dyelines of 1":20 chains, or, where detailed mapping demanded, onto larger scales of up to 1":20 feet.

Only one traverse required surveying - that of a track bulldozed in 1962 by the Electrolytic Zinc Company, from the Rosebery Cemetery to the site of diamond drill hole No. NP 107. This was carried out by the writer and J. Wilson, using a compass, and both pace and tape. Proportional correction was effected by tying the end of the traverse to a tributary of Natone Creek.

1.3 Access

Cuttings in the Emu Bay Railway provide easily accessible, if rather weathered, outcrop.

— The following are all-weather, second or third class roads:

Windy Corner (Zeehan turnoff) to Rosebery;

Windy Corner to the Misery Hill quarry;

road to the Razorback Mine and Comet Mill site;

road to the Copper-nickel deposits;

the old road ("Scenic drive") north of the Argent Tunnel;

the access road to the Renison Bell mine;

and the Williamsford-Rosebery road.

— The following are dry-weather, four-wheel-drive vehicle tracks:

Comet mill-site to Comet Creek;

Dundas farm to Comet Creek at the Adelaide mine (with difficulty);

road to the Grand Prize mine (with ease);

the North-east Dundas Tram formation to Confidence Saddle;

track to the Exe Proprietary mine (with difficulty);

DDH NP 107 track (part of the way - with difficulty);

and

a similar track to a second diamond drilling site $\frac{3}{4}$ mile further south (no outcrop).

Most of the numerous foot-tracks, with the exception of the more recent logging tracks, are shown in figure 18.

(i) The Moore's Pimple mine proved inaccessible from the Dundas side of the range, but is probably approachable from the Hercules Mine.

(ii) The Carbine track just beyond the North Comet area is well overgrown.

(iii) Wallace's Tram from Confidence Saddle to Carbine Hill is quite overgrown, and traversing is slow and difficult.

(iv) The North-east Dundas Tram from Confidence Saddle to Frazer Creek is well overgrown. The best access to the Curtin Davis area is from Williamsford, as from there the Montezuma Falls are less than one hour distant.

(v) The track to the Olympic mine is in good condition most of the way.

(vi) The track to the Colebrook mine was re-opened by the writer. It leaves the main road at the gate opposite the Golf Course green-keeper's house, and keeps to the east side of the creek.

(vii) The tracks to the Pieman River marked on the diagram are both in excellent condition. The Pieman is also easily accessible from the railway near the mouth of the Exe River. It is approachable, with difficulty, along the Stitt River from the Primrose rubbish tip at Rosebery.

Phase 1 of the investigation, with the exception of the detailed examination of the Misery Hill area, involved sampling from easily accessible roads and tracks.

In phase 2, the nature of the country served to confine the mapping to the railway, roads, tracks, and to the Pieman and some of its tributaries. The Pieman carried little water in December 1963, and allowed easy fording in three places. It was necessary to swim only the quarter-mile section round the serpentinite cliffs due north of Colebrook Hill.

Access routes to the mines used during phase 3 are indicated on figure 18.

1.4 Acknowledgements

For introducing him to Tasmanian geology, and providing guidance and encouragement through every phase of these investigations, both in the field and the laboratory, the writer is greatly indebted to M. Solomon. He also wishes to thank M.R. Banks, S.W. Carey, R.J. Ford, A.H. Spry, and R.P.B. Pitt, for most helpful advice, criticism and discussion.

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The writer very much appreciates the unselfish assistance with transport rendered by J. Sievers, of Queenstown, and R. O'Sullivan, of Zeehan.

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For the contribution of their time and typing ability, thanks are also due to Misses M. Tinkler and A. Kain.

2 GEOGRAPHY

2.1 Topography and drainage

This mountainous area (fig. 2) is dominated by the Read-Dundas Plateau (3000-3500 ft.) to the south-east. Its western and north-western flanks are deeply serrated by the headwaters of two drainage systems - those of the Pieman River to the north, and of the Little Henty River to the south-west. The south-eastern flanks of the plateau are undergoing less rapid erosion from the headwaters of the Henty River.

The divide between the Pieman and Little Henty catchments thrusts westwards from Moore's Pimple to Carbine Hill (2350 ft.) and Black Hill, where it executes a Z turn across to Serpentine Hill, and continues north-west to the boundary of the area.

Within the Little Henty catchment, two strike ridges of conglomerate - Mt. Razorback (1900 ft.) and Misery Hill (1200 ft.) - rear up above more gently undulating country. The line joining these two ridges to Carbine Hill separates the Little Henty headwaters to the west from the headwaters of the major tributary of the latter, which drains the slopes of Mt. Dundas - the Dundas River.

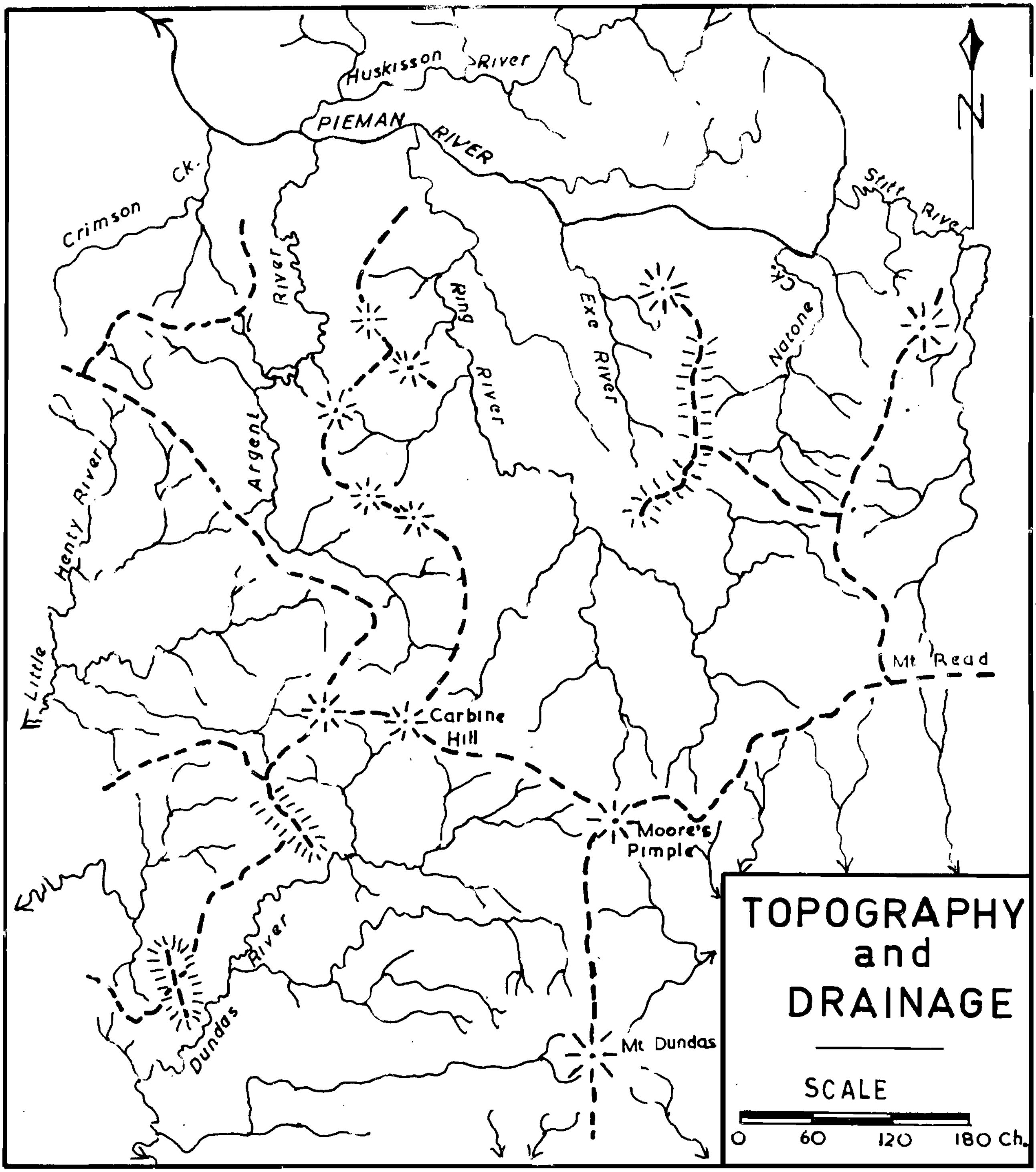

Huskisson River
PIEMAN RIVER
Crimson Ck.
Stitt River
Natone Ck.
Argent River
Ring River
Exe River
Little Henty River
Carbine Hill
Mt Read
Moore's Pimple
Dundas River
Mt Dundas
N
TOPOGRAPHY and DRAINAGE
SCALE
0 60 120 180 Ch.

FIGURE 2.

The Pieman catchment is divided into five main valleys.

The Stitt River in the far east, and Natone Creek, are separated by the elongate Mt. Read-Bald Hill spur. The latter is joined by the arcuate moraine in the valley of Natone Creek to the Colebrook Range. The broad basin to the west and south is drained by the Ring River and its rapidly incising tributaries, and the Exe River.

Parallel to the main Z divide runs a sub-divide north from Carbine Hill across Confidence Saddle to Commonwealth Hill (2200 ft.), and on to Renison Bell, Stebbins, and Dreadnought Hills, and beyond. This separates the broad Ring-Exe catchment from the narrow Argent River valley, which is in turn separated by a high (1800 ft.) range of hills to the west from Crimson Creek.

The Huskisson River, a major tributary of the Pieman, drains the northernmost part of the area.

2.2 Climate

The region enjoys a cool, wet climate, with rain throughout the year, except for hot, dry spells in the summer months, during which runoff from the areas of high relief falls almost to zero. During the rest of the year, however, snow often lies on the higher ground, although it rarely remains below 2000 ft. The average annual rainfall for Rosebery is 82 inches, and for Zeehan (to the west of the area), 97 inches, (Blissett, 1962). However precipitation varies markedly with altitude, and Loftus Hills (1915) reported an annual rainfall for Mt. Read, averaged over eight years, of 130 inches, which established it as the second wettest town (while it still existed) in Tasmania, after Lake Margaret.

Under these conditions, weathering is deep, and rock exposures must usually be sought in the beds of the larger rivers or the more actively incising creeks. The most resistant rocks sometimes outcrop along the crests of ridges like Mt. Dundas (dolerite), South Comet Ridge (conglomerate), Mt. Razorback (conglomerate), and Colebrook Hill (indurated siltstones and tuffs).

2.3 Vegetation

With the prevailing climate, the growth of vegetation is most vigourous, but as a rule it is the secondary regrowth, rather than the virgin forest, which offers most hindrance to traversing.

Easiest movement is across well cleared ground or button grass, but these were encountered only in the Dundas area.

In forest country, primary stands of Myrtle and King William Pine (Carbine Hill and Mt. Dundas), with undergrowth of man-fern (Dicksonia antarctica), are the most easily traversed, especially on ridges of medium altitude. On flatter ground above or below this, and especially in the valleys, the undergrowth thickens to a tangle of ti-tree, Bauera, and palm grass (Richea pandanifolia). "Horizontal" scrub is common in the valleys around Rosebery.

Regrowth on cleared ground, or along tracks, typically consists of ti-tree, Bauera, dogwood, cutting-grass, feather-grass, prickly mimosa, and man-fern. Such vegetation can be all but impassable.

The only apparent geobotanical association is the occurrence of eucalypts, with an underbrush of cutting-grass, ti-tree and bracken, on the serpentinite of Kapi Ridge, Melba Flats, and Colebrook Hill.

3. EXPLORATION AND DEVELOPMENT

Mineral wealth, and to a certain extent timber, are the only factors responsible for the population of this rugged region. Gold-prospectors opened up the mining fields, but the gold they found was insignificant compared with the silver, lead, zinc and tin.

The ill-managed Heemskirk tin-field was worked from 1878 for about 25 years, although one or two prospects are still being worked.

The Zeehan and Dundas silver-lead fields prospered from 1887 to about 1910, and have since been intermittently worked on a small scale. The Oceana mine (Pb-Ag) at Zeehan ceased operation in 1960, and the Stormsdown mine at Zeehan, and the Razorback mine at Dundas (both tin), are the only present producers.

In 1890, the Renison Bell area was accessible from Zeehan across Confidence Saddle, and alluvial tin and gold were found in the Ring River. The tin-bearing sulphide ore being worked today was known, although little prospected, by 1895 (Montgomery, 1895).

The construction of the North-east Dundas Tram in 1898 facilitated the development of the complex antimonal lead deposits in the precipitous southern watershed of the Ring River. This field was active from 1890 to the outbreak of war in 1914.

Access to the Mt. Read area was first obtained in 1877 by T.B. Moore, who cut the first track from Zeehan across the ridge which now bears his name. The first lead-zinc was found about 1891, while the gossans that were the source of the alluvial gold were being worked for that metal. The Rosebery area to the north was opened up in 1893, and has been in continuous production since the 1920's.

Exploration of the area since World War II has been very extensive. Zeehan Explorations (North Broken Hill and Broken Hill South) examined the Zeehan and Dundas field in detail. Geophysical surveys were made by the Bureau of Mineral Resources at Cuni, north of Zeehan, at Renison Bell, and between the Razorback and Grand Prize tin deposits. One such survey is currently investigating the Oonah mine area.

From 1951 to 1954, detailed geological surveys were made near Zeehan, Renison Bell, and north across the Pieman River by the Department of Mines.

From 1956 to 1962 the area has been re-examined by geologists and geophysicists of Rio Tinto Exploration Pty. Ltd.

Geological investigation of the area by the University of Tasmania has been almost continuous since 1947.

4. STRATIGRAPHY

Summary. Although fossiliferous Silurian rocks were known on the West Coast as long ago as 1862 (Gould), the ages of the older formations were unknown for many years, and the position was complicated by Hall (1902) when he reported *Diplograptus* in rocks now known to be Cambrian.

Chapman (1926) doubtfully ascribed a marking in slate just north of Farrell Siding on the Hatfield Plains to the Middle Cambrian (or Cambrian) genus *Hurdia*. This identification has played an important part in the controversy over the age of the Mount Read Volcanics (Campana et al., 1960; Banks and Solomon, 1961; Campana, 1961).

Thomas (1945) rejected Hall's identification of *Diplograptus*, and therefore the supposed Ordovician age of the rocks.

Thomas and Henderson (1945) described dendroids in black shale at the Razorback Mine, and established a Middle Cambrian age for this horizon in the Dundas Group.

Lewis (1940) and Kobayashi (1940) demonstrated the Ordovician age of the Junee Group which overlies the Dundas Group at

Misery Hill, and the Huskisson Group on the Huskisson River.

The provisional term "Pieman Group" was given by Hills and Carey (1949) to all Tasmanian rocks ranging from Upper Proterozoic to Cambrian.

Opik (1951a, b, c) showed that the Dundas Group includes Middle to Upper Cambrian rocks, basing his arguments on

(a) trilobites collected by Elliston, Kay, and others at Dundas in 1950;

(b) fossils, including dendroids, found by Elliston and Taylor on the Huskisson River in 1951;

(c) trilobites discovered in the Leven Gorge in northern Tasmania by Cooper and Banks.

Elliston (1951, 1954) defined the Dundas Group, based on Opik's interpretation, and also the underlying Carbine Group, which he thought was probably Upper Proterozoic to Lower Cambrian — a view which has not so far been invalidated.

Taylor (1954) defined the Success Creek Group north-west of Renison Bell, and tentatively correlated it with the Carbine Group. He also described for the first time the Crimson Creek Argillite, an important succession between the Proterozoic-Lower Cambrian and Dundas

Group — a period to which previous workers had assigned an unconformity.

The age of the Hatfield Plains slate must be regarded as unknown following the investigation of <u>Hurdia</u> by Banks (1962), who was unsure that the marking was even organic in origin.

Blissett (1962) showed that

(a) the Carbine Group-Success Creek Group passes up "without a major hiatus" into the Crimson Creek Formation;

(b) the Dundas Group lies conformably on the Crimson Creek Formation; and

(c) there is a possible conformity between the Dundas Group and overlying Junee Group rocks on Misery Hill and on the Huskisson River.

Campana and King (1963) disagree with point (a) above.

4.1 Carbine Group - Crimson Creek Formation - Dundas Group.

The interpretation by various workers of the succession in the Dundas area is summarized in Table I. Elliston's (1954) version of the geology is given in Figure 3. Figure 4 shows the interpretation of Blissett (1962).

An inlier of Older Proterozoic schist is unconformably overlain by the Carbine Group, which Blissett (1962) considers is in turn conformably overlain by the Crimson Creek Formation. The homoclinal Dundas Group rests conformably on the Crimson Creek Formation, and passes upwards, possibly without a break, into the Junee Group, at Misery Hill.

Concert Schist (Blissett, 1962) = Davey Group (Elliston, 1954). (Lower Proterozoic).

This was not examined in detail by the writer, although the unconformable contact with the Carbine Group was observed on spur track 2 (see Fig.22B).

31420 is a very fine-grained sericite schist which has undergone at least two deformations, the sericite showing minute chevron folding.

	ELLISTON, 1954.	BANKS, 1956 (using Pettijohn, 1949)	BANKS, 1962	BLISSETT, 1962
	Junee Group	Junee Group	Mt. Zeehan Congl. (Ordovician)	Junee Group
	—— Fault ?? ——	—— Fault ——		—— Fault contact ? ——
DUNDAS GROUP	500' Misery Conglomerate	M. (Subgreywacke) Congl.	500' M. Conglomerate	500' M. Conglomerate
	2000' Climie Slate & Tuff	C. Slate and Tuff	2000' C. Siltstone & G/wacke.	1500' C. sh., slt/s., g/w., congl., slate.
	470' Fernflow Congl. & Tuff	F. Subgreywacke & Congl.	470' F. G/wacke & Conglomerate	500' F. greywacke & congl.
	1050' Comet Slate & Tuff	C. Slate & Subgreywacke.	1050' C. Siltstone & Greywacke.	500'-1000' C. g/w congl., slt/s., g/w grit., sh., slate.
	1950' Fernfields Tuff & Congl.	F. Subgreywacke & Congl.	1950' F. G/wacke & Conglomerate	0-1950' F. g/w., slt/s., congl.
	2450' Brewery Junction Slate and Tuff	B.J. Slate & Tuff = Curtin Davis Volcanics.	2450' B.J. Slate & Tuff.	2000' B.J. slt/s., sh., g/w., slate, tuff.
	1000' Curtin Davis Volcanics.			
	225' Razorback Conglomerate	R. (Subgreywacke) Congl.	250' R. Conglomerate	250'-750' R. Conglomerate.
	30' Hodge Slate	H. Slate	600' H. Slate	500'-600' H. Slate
	250' Red Lead Conglomerate & Tuff.	R.L. Conglomerate	400' G/wacke congl. = ? 250' Red Lead Conglomerate	150'-400' R.L. Congl. = ? S.C. Grit.
	800' Severn Slate	S. Slate	800' S. Slate	200' Judith slt/s.
				5600'-8900'
	150' South Comet Grit	S.C. Greywacke	150' S.C. Greywacke	Crimson Creek Formation
	200' Judith Slate and Tuff	J. Slate & Subgreywacke	200' J. Slate & G/wacke.	
	11,575' Unconformity	Unconformity	....contact with	
	Carbine Group	Carbine Group	Carbine Group	Carbine Group
	Unconformity			Unconformity
	Davey Group			Concert Schist.

TABLE I

INTERPRETATIONS OF THE SUCCESSION IN THE DUNDAS AREA

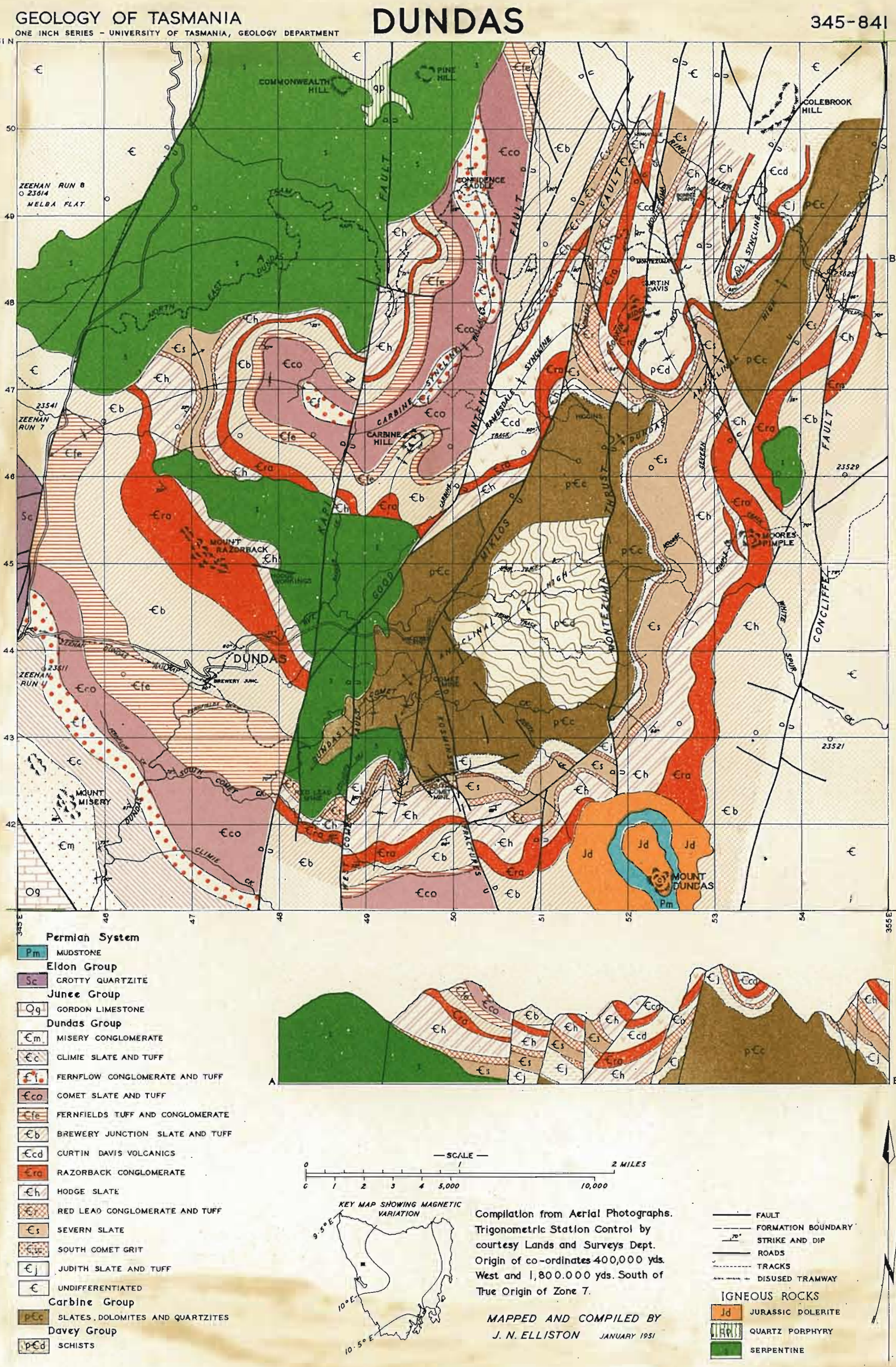

GEOLOGY OF TASMANIA
ONE INCH SERIES - UNIVERSITY OF TASMANIA, GEOLOGY DEPARTMENT
DUNDAS
345-841
Permian System
Pm MUDSTONE
Eldon Group
Sc CROTTY QUARTZITE
Junee Group
Og GORDON LIMESTONE
Dundas Group
€m MISERY CONGLOMERATE
€c CLIMIE SLATE AND TUFF
€f FERNFLOW CONGLOMERATE AND TUFF
€co COMET SLATE AND TUFF
€fe FERNFIELDS TUFF AND CONGLOMERATE
€b BREWERY JUNCTION SLATE AND TUFF
€cd CURTIN DAVIS VOLCANICS
€ra RAZORBACK CONGLOMERATE
€h HODGE SLATE
€r RED LEAD CONGLOMERATE AND TUFF
€s SEVERN SLATE
SOUTH COMET GRIT
€j JUDITH SLATE AND TUFF
€ UNDIFFERENTIATED
Carbine Group
p€c SLATES, DOLOMITES AND QUARTZITES
Davey Group
p€d SCHISTS
SCALE
2 MILES
10,000
KEY MAP SHOWING MAGNETIC VARIATION
Compilation from Aerial Photographs. Trigonometric Station Control by courtesy Lands and Surveys Dept. Origin of co-ordinates 400,000 yds. West and 1,800.000 yds. South of True Origin of Zone 7.
MAPPED AND COMPILED BY
J. N. ELLISTON JANUARY 1951
FAULT
FORMATION BOUNDARY
STRIKE AND DIP
ROADS
TRACKS
DISUSED TRAMWAY
IGNEOUS ROCKS
Jd JURASSIC DOLERITE
QUARTZ PORPHYRY
SERPENTINE
COMMONWEALTH HILL
PINE HILL
COLEBROOK HILL
CONFIDENCE SADDLE
CARBINE HILL
MOUNT RAZORBACK
DUNDAS
MOUNT MISERY
MOUNT DUNDAS
MOORES PIMPLE
CURTIN DAVIS
KAPI FAULT
GOOD FAULT
MIKLOS THRUST
MONTEZUMA
CONCLIFFE FAULT
ZEEHAN RUN 8
MELBA FLAT
ZEEHAN RUN 7
ZEEHAN RUN 4

Figure. 3.

31421 is a graphitic quartz schist. Both of these specimens were collected outside the area of Lower Proterozoic delineated by either Elliston or Blissett, which suggests that complex faulting of the area may have produced several scattered inliers of schist not yet properly mapped.

Blissett considers that the above schists, together with quartz-mica schist, are the products of low grade regional metamorphism of an unknown thickness of greenish-grey and grey sandstone, siltstone, and shale. The schistosity strikes generally NW, and bedding is largely obliterated.

<u>Carbine Group (Elliston, 1954) = Oonah Quartzite and Slate (Blissett, 1962). (Upper Proterozoic to Lower Cambrian).</u>

Elliston divided his type section, which is 2000 ft. thick, into three formations, which are not claimed to be in an established stratigraphic order.

The <u>Higgins Slate and Quartzite</u> consists of rolled, contorted and puckered black slates, with interbedded, sharply folded, grey micaceous quartzites (Elliston).

The <u>Platt Dolomite</u> contains occasional crystals of galena, specks of pyrite, and quartz, and is riddled with calcite veins (Elliston). Blissett considers that some of the dolomite in the area has been formed by the dolomitization of serpentinite. The writer has certainly observed such dolomite in the vicinity of the Razorback Mine, and it may also be present beneath gossanous material along the track from the Comet mine to Dundas, where fault blocks of serpentinite and Carbine Group sandstones and shales are complexly juxtaposed.

Elliston suggested that the Maėstries Dolomitic Conglomerate, of rounded quartz pebbles in a dolomitic matrix, was basal to the Carbine Group. Blissett describes it as being impersistent, and at least near the base. This horizon was not seen by the writer.

The rudites in this sequence are typically micaceous, fine-to-medium grained sandstones (31414, 31416, 31417), although some sandstones are relatively clean (31409). The lutites are fine-grained siltstones, which often show signs of graded bedding (31415).

Crimson Creek Formation

A comparison of figures 3 and 4 shows one of the main differences between the two interpretations. Blissett, believing the sequence from Upper Proterozoic to Junee Group time to be continuous, has swung the Dundas anticlinal high around to the south, and has flanked the Carbine Group around its core with the Crimson Creek Formation, which incorporates many of Elliston's Dundas Group correlates. Some of the latter have even been relegated to the Carbine Group itself, to the west of Mt. Dundas.

The uniform stratigraphy of the Formation at Dundas is little different to that in its type area, which is discussed in the next section.

Dundas Group

Elliston defined the Dundas Group as: "the group of formations exposed in the section along the Dundas Rivulet between the serpentine contact north of the Razorback and Mount Misery, together with those exposed on Spur Track 2 from a point 800 feet beyond its recrossing of the Dundas Rivulet to the tributary of White Spur Creek". (Fig. 3).

Blissett (Fig. 4) interpreted the sequence differently, and disregarded the above definition, although he retained most of the formation names. He did not commit himself (on the map at least) to a stratigraphic succession along $1\frac{1}{4}$ miles of the Dundas River, and he assigned the whole succession on Spur Track 2 to the underlying Crimson Creek Formation, thus completely re-interpreting Elliston's three basal formations, the Judith Slate and Tuff, the South Comet Grit (both these described from the South Comet Creek area), and the Severn Slate (described from Spur Track 2).

The reasons for this change are as follows:

(a) The original *Ptychagnostus gibbus* fauna (Opik, 1957a, b; Banks, 1956) was found in a loose boulder, and no similar material has since been discovered. A.B. Gulline mapped thin-bedded pale yellowish or cream shale and greywacke in the same area, west of the South Comet mine. He found a fossil-fragment horizon below at least 100 feet of sheared greywacke conglomerate, the South Comet Grit of Elliston, which Blissett considered to closely resemble both the Red Lead Conglomerate, and a conglomerate mapped below the Hodge Slate near the Razorback mine by Blissett and Gulline (1961b).

Elliston thought the fossil horizon to be basal Judith Formation, whereas Blissett, unsure of the field relations of the Judith Formation because of complex folding and faulting, tentatively placed it below the Red Lead Conglomerate (= South Comet Grit). Only the top 200 feet of Elliston's Judith Formation were therefore retained by Blissett in the Dundas Group, the rest being relegated to the Crimson Creek Formation.

(b) Elliston did not find fossils in what he believed was the equivalent of the Judith Formation on Spur Track 2, and Blissett considered that correlation over several miles on lithological grounds alone was unreliable. He placed the whole sequence in this area in the Crimson Creek Formation, and thus the Severn Slate is also relegated. (Blissett, 1962; p. 28).

Red Lead Conglomerate and Tuff (Elliston, 1954); Red Lead Conglomerate (Blissett, 1962).

Typical are purplish-red, grey and greenish greywacke conglomerate (Pettijohn, 1957) and pebbly grit. These contain rounded, subangular and angular pebbles and cobbles of chert and quartzite, set in a matrix of greywacke grit. The formation is about 250 feet thick in South Comet Creek, but may be as much as 400 feet thick north of the Razorback Mine. (Blissett, 1962).

The writer examined the conglomerates on the ridge south of the South Comet mine. (31423-31425). It is here of rather open framework, and very poorly sorted, with angular fragments ranging from two to three feet across, down to matrix size, of chert, quartzite, and siltstone. There are finer bands which, as reported by Elliston, show faint current bedding. No graded bedding was seen. Because no fossils have been found in the overlying siltstone to the south, Blissett is cautious about assigning this occurrence to the Red Lead Formation, and the writer would agree that "the formation resembles the Razorback Conglomerate and certain horizons in higher conglomerates in the Dundas Group". (p.33). The stratigraphic position of the South Comet ridge conglomerate is therefore uncertain.

Hodge Slate (Elliston, 1954).

The writer examined this formation on the north-west shoulder of Mt. Razorback, (31399), and in a fault block (Blissett) just to the east of the Dundas farm (31403). The latter outcrop was investigated exhaustively for the basic lavas which Elliston claimed were at this horizon along the North-east Dundas Tram. Because field misidentification of the rocks in the Dundas Group has been not uncommon, the writer cut thirteen slides of a section through the outcrop around 31403. All revealed a carbonaceous(?) medium-grained siltstone, and Elliston's correlation could not be confirmed.

Specimen 31399, collected six feet below the contact with the Razorback Conglomerate, is also a coarse to medium grained siltstone.

This examination supports Blissett's observation that the formation is composed of laminated and unlaminated siltstones. These often contain greywacke partings, especially at locality 31399. The designation "slate" is therefore inappropriate, even though the siltstones are highly cleaved in places (Banks, 1956).

Razorback Conglomerate (Elliston, 1954).

These characteristically hard, grey rocks were examined in detail on the summit of Mt. Razorback. They consist of all size-ranges from boulder conglomerate, with boulders up to a foot across, through a mode of small-cobble conglomerate, to coarse grained sandstone, and contain angular and rounded fragments of chert, jasper(?), quartzite, vein quartz(?), siltstone (some ferruginous), slate, and a little plagioclase felspar (31395, & Plate 1). The sorting is generally poor, but where the grain size distribution becomes approximately bimodal about inclusions and matrix, the fabric is usually only partly open, and the rock is not quite a paraconglomerate (Pettijohn, 1957). In the coarser beds, the finest fractions are also medium to coarse sands, so that the sorting is effectively even poorer.

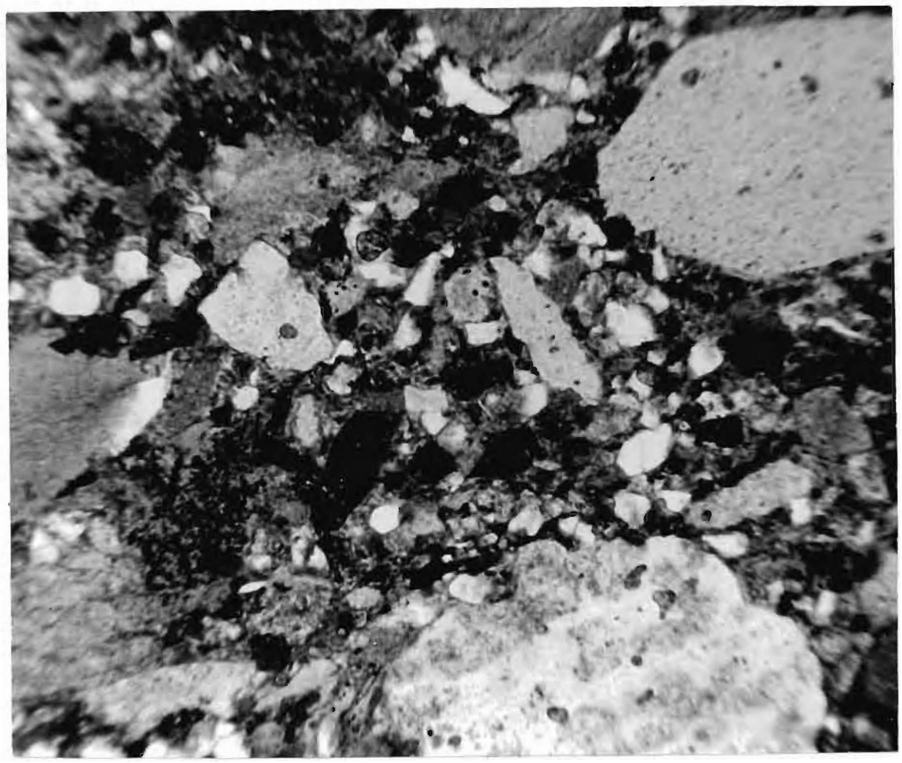


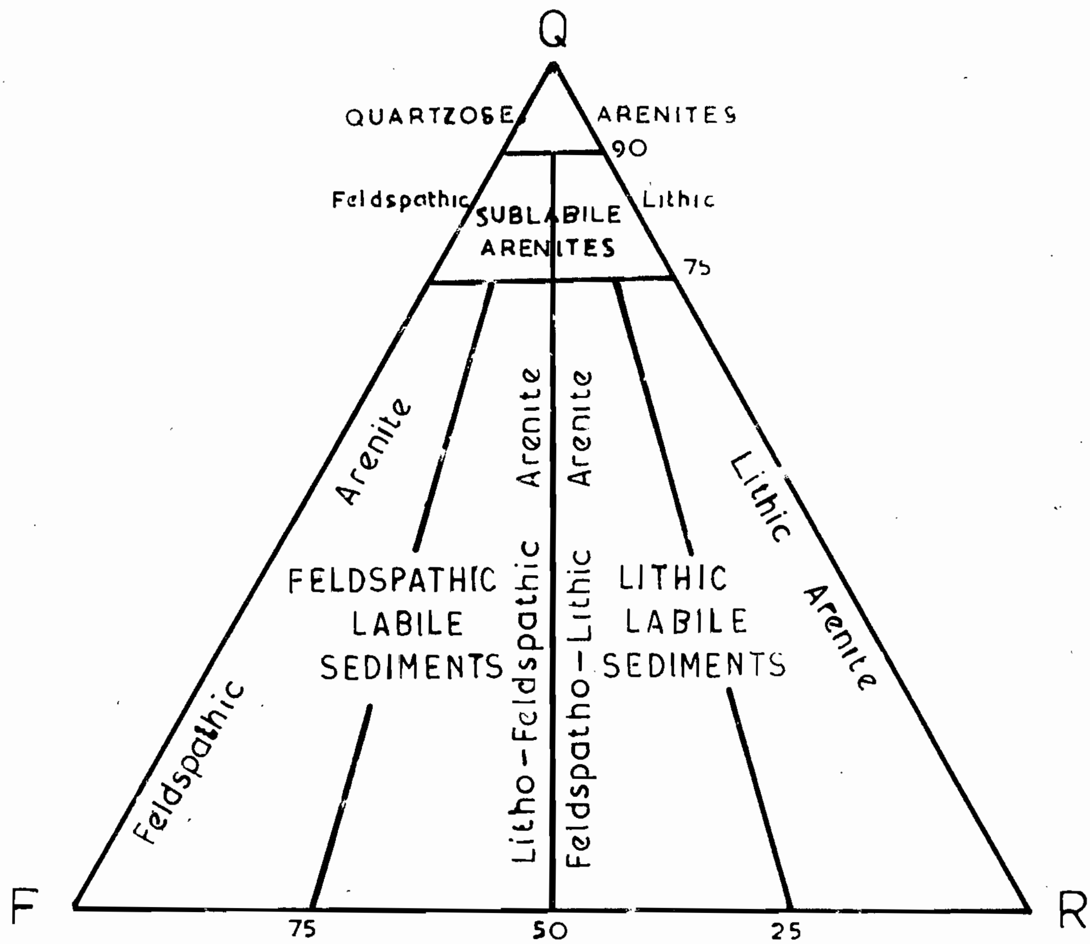
Plate 1.- 31396. Greywacke conglomerate, showing bimodal distribution of grain-size. Rock fragments are slate and siltstone (grey) and chert (white). The groundmass consists of quartz (white), feldspar (cloudy), chlorite and iron--ore (black) and some small grains of augite. Razorback Conglomerate. Plane-polarised light. (X37).

It is true, as Elliston points out, that this horizon is different from other breccias and conglomerates in the Dundas Group; but it is not "very" different, and as several subsequent workers have shown, the difference does not consist in one being clastic, and the other pyroclastic.

Brewery Junction Formation (Blissett, 1962).

Twenty-six of the microscopically examined specimens from this formation are definitely modal about a fairly well-sorted grey to green or purple fine-grained lithic sublabile greywacke (Crook, 1960): (Fig. 5). This is a slightly coarser mode than the siltstone mode proposed by Blissett on the basis of field identifications. A typical greywacke is illustrated in Plate 2.

At the base of the formation occurs an horizon which Banks (1956) described as containing keratophyric tuff. East of the Dundas form, there occurs a limited outcrop of coarse-grained to granular felspathic greywacke or microbreccia, consisting of abundant angular altered volcanic felspar (plagioclase and orthoclase(?)) and volcanic quartz fragments (Plate 3). Specimens 31400-2 show that the very fine-grained groundmass is predominately leucoxene and chlorite. These rocks may not be true tuffs, but 31385 ~~(Plate 4)~~, along strike to the north-west, is a true glassy tuff, containing fragments of lava, which may be keratophyric.



Q = Quartz + Chert

F = Feldspar

R = Rock fragments + other labiles (e.g. mafics, chlorite)

ARENITE = Greywacke / Arkose / Quartz Sandstone

FIGURE 5: Classification of Arenites. (Crook 1960)

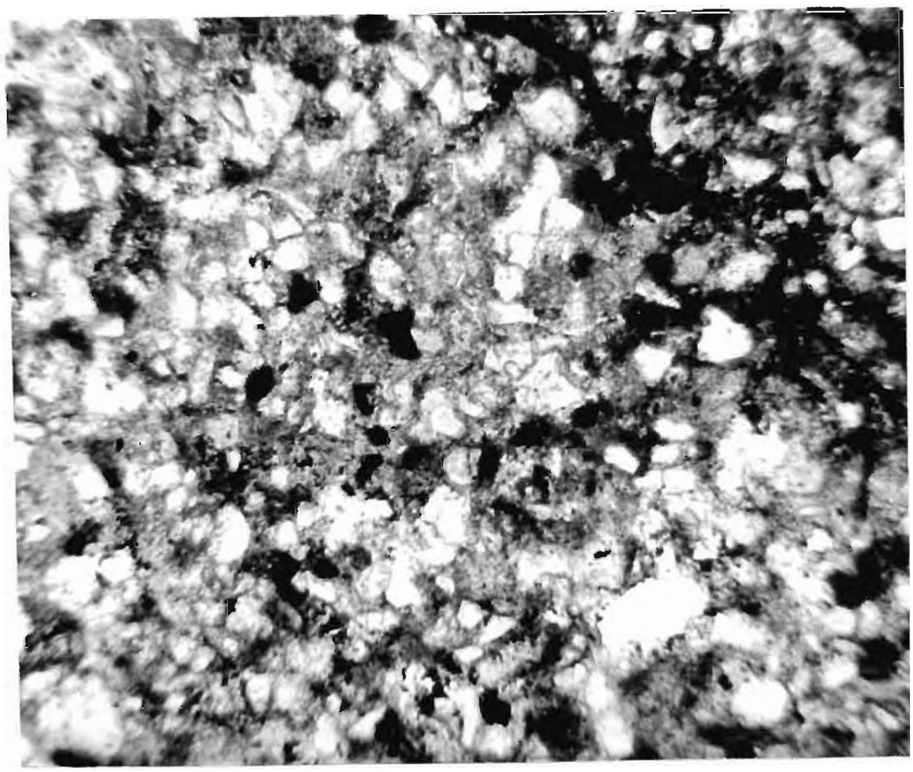


Plate 2.- 31384. Fine-grained, lithic sublabile greywacke, containing quartz (clear) and some feldspar (clouded), with iron-ore and chlorite (black). The dark band (u. right) is rich in oriented chlorite. A typical greywacke from the Brewery Junction Formation. Plane-polarised light. (X92).

Plate 3.- 31400. Coarse-grained feldspathic greywacke or microbreccia, containing fragments of quartz (clear) and plagioclase (cloudy) in a dark, aphanitic groundmass, probably leucoxene and chlorite. The rock also contains sparse shale fragments. Brewery Junction Formation. Plane-polarised light. (X37).

The formation became coarser towards the top, with purple and green lithic greywacke grits, some poorly sorted, and some (e.g. 31364) containing leucoxene in the groundmass.

Fernfields Formation (Blissett, 1962).

This was found to be a characteristically rudaceous rock, the commonest forms being purple to green, poorly sorted, very coarse-grained lithic greywackes and large pebble conglomerates, with some boulder conglomerates. The fragments are siltstones, lithic greywackes, cherts, quartzites, and quartz.

Pettijohn's (1957) "paraconglomerate" would describe these rocks, except that they usually exhibit a continual gradation in grain-size (31352, 31358). Specimen 31353 does suggest a bimodal distribution of grain-size but Blissett has described some horizons containing a few large pebbles or cobbles scattered through a gritty matrix (true paraconglomerate), and there is probably a continuous spectrum between this type of bimodal distribution and the 31352 type of texture. Thus any bimodal distribution in this formation may be fortuitous, and meaningless.

Plate 4 illustrates a spilite (?) pebble from this formation.

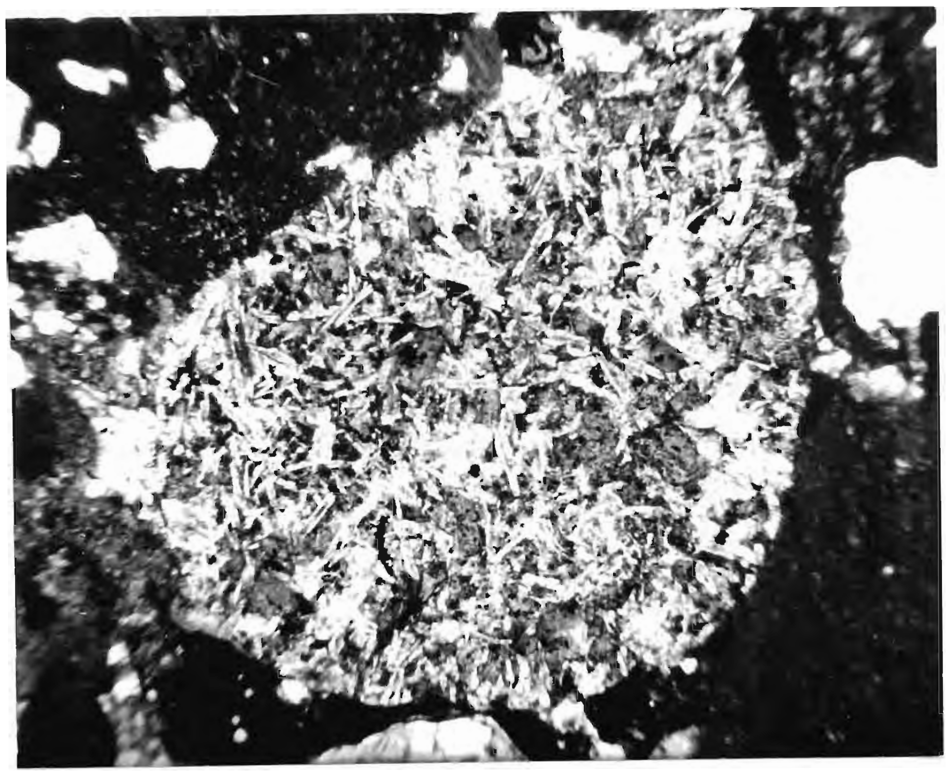


Plate 4.- 31356. Spilite fragment, with sodic plagioclase and chloritised amphibole, from a greywacke grit in the Fernfields Formation. Plane-polarised light. (X37).

Comet Formation (Blissett, 1962).

Not many specimens were collected by the writer from this formation, but they show a range in grain-size from a medium-grained lutite (31348) to a very coarse pebble conglomerate (31349). The sorting is poor. Blissett (p. 35) describes the formation thus:

"It ..... consists of purple, green and grey siltstone, mudstone, and shale, with scattered bands of greywacke-conglomerate and greywacke-grit. The shale or siltstone is locally highly cleaved and slaty, though bedding is usually visible".

Fernflow Formation (Blissett, 1962).

There seems to be little difference between this formation and the two previously described. Blissett stresses the abundance of coarse green or purple conglomerate, but the writer found a substantial proportion of the rocks to be fairly well sorted fine to coarse lithic greywackes, or pebble greywacke conglomerates (Pettijohn, 1957), similar in composition to those in the Fernfields. (Plate 5).

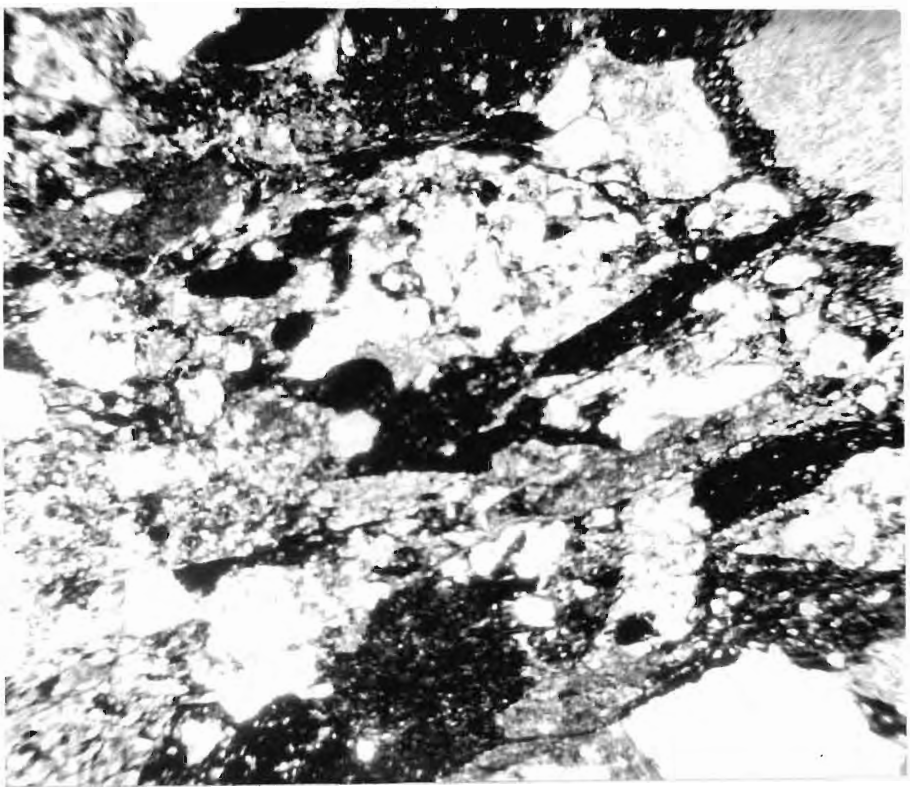


Plate 5.-31333. Coarse-grained, lithic greywacke with angular fragments of quartz(clear), shale (dark grey) and iron-ore (black), in fine-grained quartz-chlorite-kaolin-iron-ore groundmass. Fernflow Formation. Plane-polarised light. (X37).

The area in Elliston's type-section covering the topmost section of the Dundas Group — around Misery Hill — was examined in detail by the writer. The formations involved are the Climie Formation and the Misery Conglomerate, and the Ordovician rocks above. Figure 6 gives a general view of the relationship of the area to overlying formations, and figures 3 and 4 give the interpretations of the area according to Elliston and Blissett respectively.

The writer was not qualified, with limited field data, to draw any conclusions concerning the age of the Misery Conglomerate, or its correlation with other formations. The investigation concentrated on attempting to establish a stratigraphic relationship between the Dundas Group and the Junee Group. To this end, the north-western half of the hill, its western slopes, and the outcrop in the Dundas Rivulet north-east of the Queenstown road were thoroughly studied (Fig. 7).

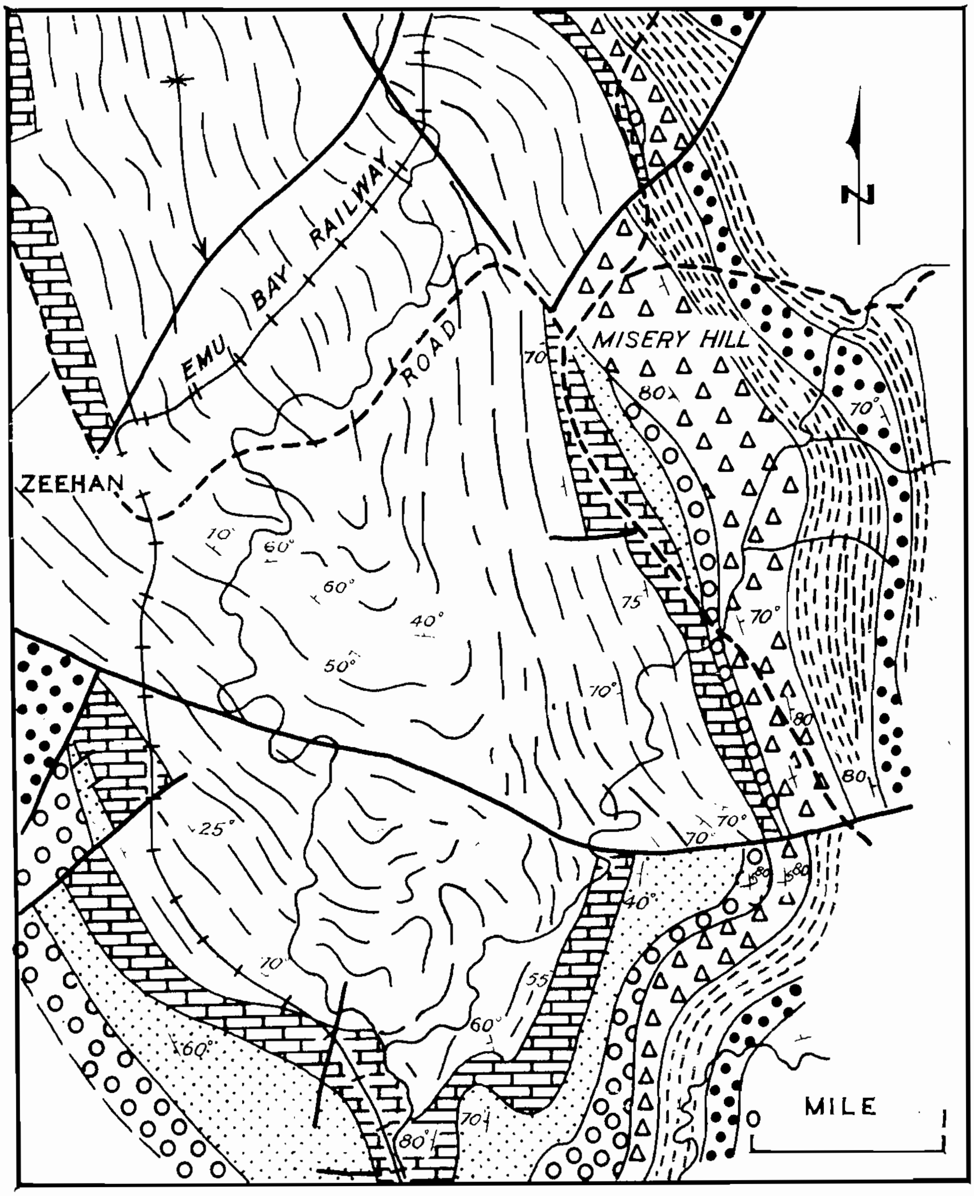
This examination is a detailed repetition of similar studies of Misery Hill by Elliston (1954), Bradley (1954), Solomon (1958), Blissett (1962), Campana and King (1963) and many other casual workers.

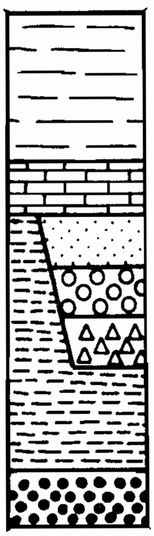
A: Stratigraphy

Climie Formation (Blissett, 1962).

Blissett's Zeehan Sheet is a little misleading in its representation of that author's interpretation of the extent of outcrop

FIGURE 6.





SILURIAN – LOWER DEVONIAN
(ELDON GROUP)

GORDON LIMESTONE
MOINA SANDSTONE
MT ZEEHAN CONGLOMERATE

} ORDOVICIAN (JUNEE GROUP)

MISERY HILL CONGLOMERATE
DUNDAS BEDS UNDIFFERENTIATED SHALES SLATES LENSES OF GREYWACKE CONGLOMERATE TUFF(?)
GREYWACKE CONGLOMERATE GREYWACKE TUFF(?) AND SHALE LENSES

} UPPER & MIDDLE CAMBRIAN

After Campana (1962).

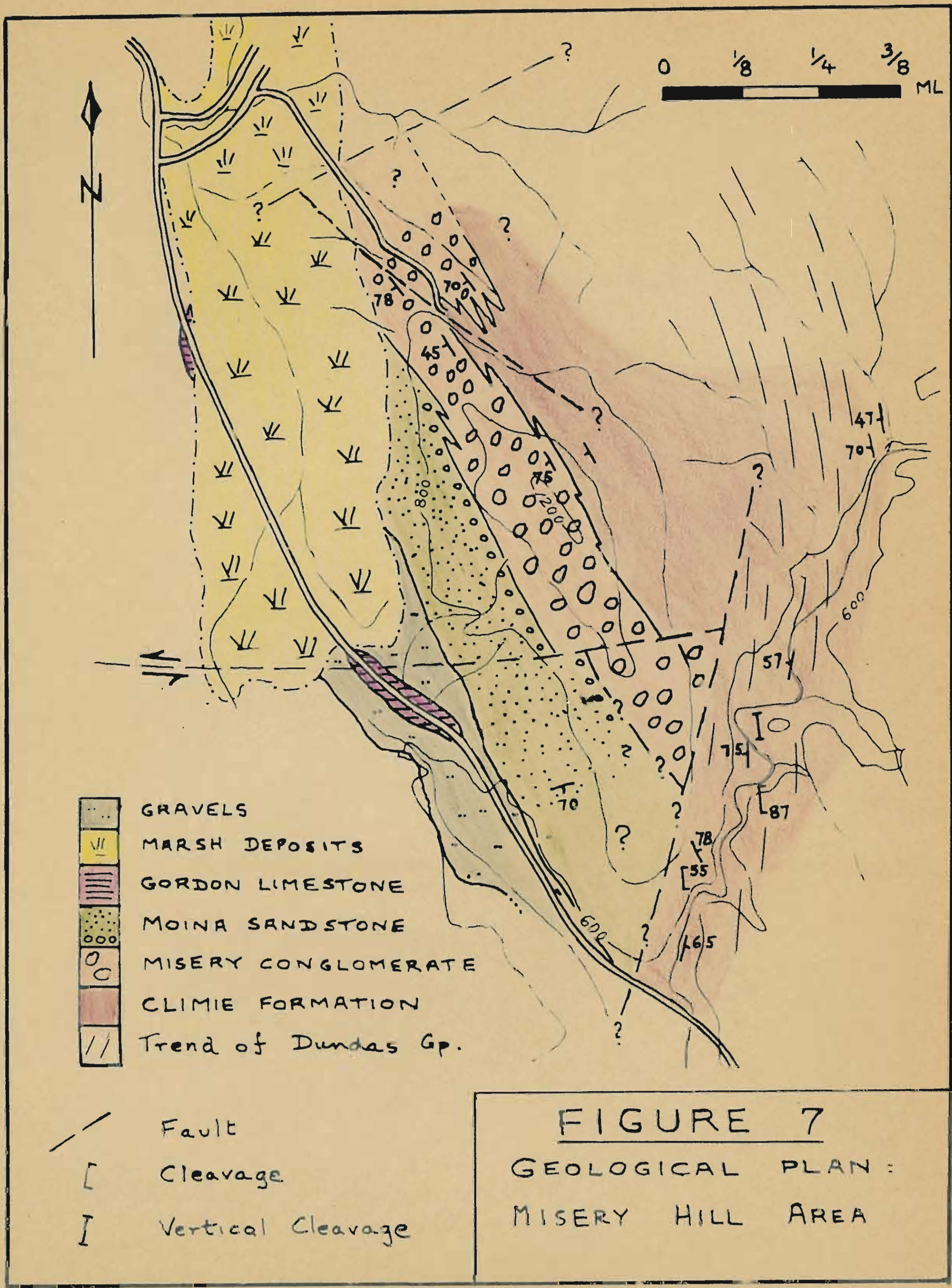


FIGURE 7

GEOLOGICAL PLAN: MISERY HILL AREA

of this formation, as expressed on pp. 36 and 55 of his Explanatory Report. In the former, the succession on the Dundas River is designated "Cambrian, Unassigned", whereas in the Report, this area is mapped and discussed as Climie Formation, following Elliston's interpretation. The writer follows the Report rather than the sheet.

Blissett describes the formation as consisting of purple and green greywacke, silstone, and highly cleaved slate, with conglomerate bands in the lower part, which became fewer and thinner upwards.

Twenty-one slides from the formation reveal it to be predominately sand-size, and modal about a medium to fine grained lithic sublabile greywacke. There is a remarkable coincidence of variation in grain size along the two sampling traverses at each end of Misery Hill, but this must be purely fortuitous, as it is very difficult to conceive that the same beds were being sampled in each case.

Banks (1962) termed the formation the Climie Siltstone and Greywacke. The order of words in this name could well be reversed, on petrographic evidence.

Misery Conglomerate (Elliston, 1954).

This distinctively red succession has been well described by other authors (q.v.). The size-range is from very fine-grained ferruginous lithic arenite, to large (1 ft.) boulder conglomerate. The fragments are generally rounded, and are composed of quartzite, chert, jasper (?), quartz, greywacke and ferruginous siltstone (Plate 6). The fabric tends to be open, and the colour is due to both ferruginous inclusions, and detrital(?) hematite. The grainsize distribution is usually gradational, but is sometimes bimodal, with sparse cobbles in a lithic arenite matrix. The latter type is an unstratified-matrix paraconglomerate (Pettijohn, 1957, p. 261), not dissimilar in texture to certain horizons in the Fernfields Formation.

Moina Sandstone (Blissett, 1962).

Blissett considers the grey, closed-fabric, pebble to cobble conglomerate above the red Misery Formation to be the base of the Moina Sandstone, which is a pink-stained, pale grey, saccharoidal grit or quartzose sandstone (31302), quite unlike any of the arenites in the Dundas Group.

B. Field relations

The method of investigation was to attempt a verification of Blissett's map of the area. (Fig. 4; and Blissett, p. 54).

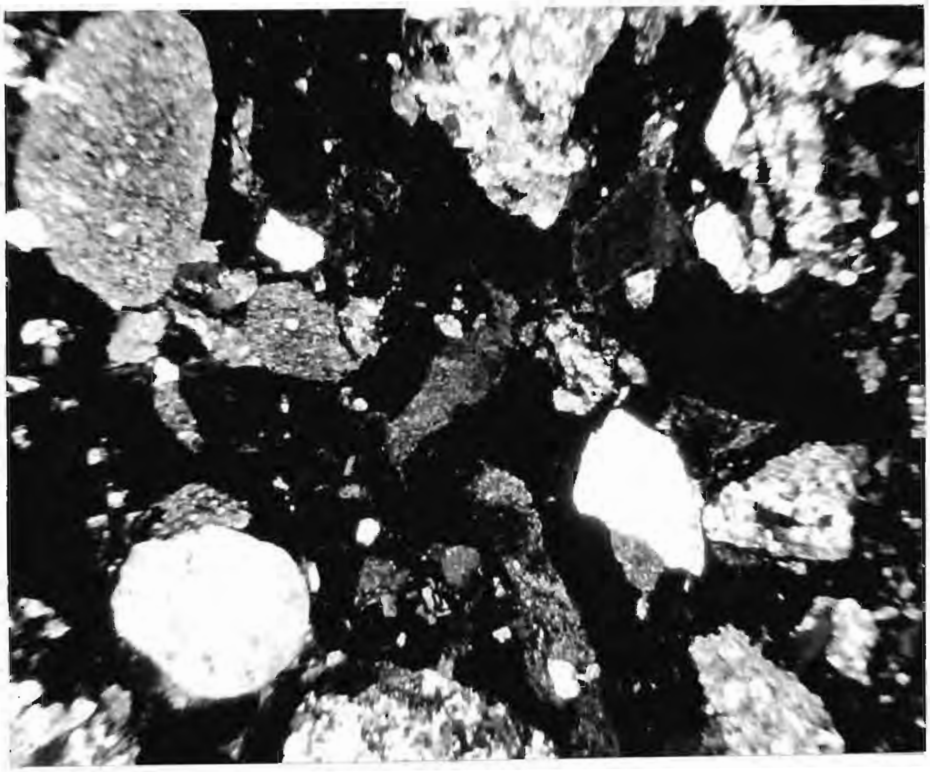


Plate 6.- 31308. Very coarse-grained, ferruginous lithic labile arenite, showing fragments of chert (b. centre), quartz (clear) and shale (dark grey), with fine-grained quartzite. The cement is haematite or limonite. Misery Conglomerate. Crossed nicols. (X37).

The following conclusions were reached:

(a) Blissett's extensive block faulting is probably misinterpretation. He has used it in several places to explain juxtapositions of conglomerate and finer sediments, but Elliston's field description of interdigitating lenses is correct, and faults are unnecessary. The presence of a dip-slip strike fault in the Misery Hill Quarry, which dips west and is reverse, does not invalidate this analysis.

(b) The interdigitating lenses occur in the Climie Formation, between the Climie and the Misery Conglomerate, and within the Conglomerate. The contact between the Misery and the basal conglomerate of the Moina sandstone was not positively identified.

(c) The stratigraphic position of the Dundas Rivulet succession, along strike from the Climie at the northern end of Misery Hill, is unclear. It could easily include the Comet and Fernflow. The overturning of the succession near the Queenstown Road bridge (Blissett, p. 53) is also unproven. No criterion of attitude was seen in the steeply east-dipping rocks at this locality.

(d) Cleavage in these rocks could not be regarded as "slaty". (Blissett, p. 36). Weathering has merely highlighted the fissility of many of the lutites. True slates, or even laminated siltstones, were not seen.

(e) The relationship of the Moina sandstone to the Gordon Limestone at the foot of the hill is not clear. Blissett infers a fault between the two because of a difference in trend between the Moina and the limestone flat, which is poor evidence — first because the flat may not uniquely represent the Gordon, and secondly because the highly lenticular nature of the beds right across Misery Hill precludes the necessity of individual strikes paralleling the general outcrop trend. Thus Campana and King (1963) report that the Misery Conglomerate lenses from 2000 feet to some 300 feet in two miles.

(f) Conclusion. Outcrop at Misery Hill is insufficient to give a definite stratigraphic tie between the Dundas and Junee Groups. There is structural conformity, and no evidence of note to suggest strike-faulting between the two. The succession is probably unbroken.

Summary of Dundas Area Stratigraphy

Ordovician:	-	Gordon Limestone
	-	Moina Sandstone
Cambrian ?:	-	Misery Conglomerate
Cambrian:	-	Climie Formation: siltstone; predominant medium to fine grained lithic sublabile greywacke; conglomerate.
	-	Fernflow Formation: fine to coarse lithic greywackes, and greywacke conglomerates.
	-	Comet Formation: medium grained lutite predominates, with greywacke conglomerate and greywacke grit.
	-	Fernfields Formation: predominant very coarse-grained lithic greywackes and large pebble greywacke conglomerates.
	-	Brewery Junction Formation: predominant fine grained lithic sublabile greywacke; tuff; greywacke grits.
	-	Razorback Formation: predominant conglomerate, and coarse-grained sandstone.
	-	Hodge Formation: medium-grained siltstones.
	-	Red Lead Formation: predominant conglomerate; greywacke grit.
	-	Judith Formation: shale and siltstone with greywacke (?).
Lower Cambrian:	-	Crimson Creek Formation: siltstones and greywackes.
Upper Proterozoic to Lower Cambrian (?)	-	Carbine Group: sandstones and shales.
Older Proterozoic	-	Concert Schist.

The following comments are appropriate here:

(a) Original field identification of tuffs and other pyroclastics has been gradually corrected since 1954 by various workers (Table 1). Little volcanic material was recorded in the present study. The question of lava horizons is discussed in section 5.

(b) The detailed succession in the Dundas Group can only be of local significance because of the strong lensing in most horizons. Conglomerates in particular cannot be traced for more than a few miles.

(c) The Razorback-Hodge horizon forms a reasonably good marker horizon in the Dundas-North-east Dundas area, but Blissett considers that Elliston wrongly identified the combination in several places — particularly on Moore's Pimple, where the conglomerate has been assigned to the Crimson Creek Formation by Blissett, and to the Rosebery Series (Finucane, 1932), which occurs typically west of Rosebery, by Campana and King (1963).

(d) Despite its <u>apparent</u> distinctiveness, the "Razorback Conglomerate" may not represent one time-horizon in the succession, and correlation on lithological grounds alone is dangerous. Further, as will be seen in section 6, the genesis of the rock is not necessarily distinctive.

4.2 Success Creek Group - Crimson Creek Formation - Huskisson Group.

The type sections of these successions (Taylor, 1954) occur in the far north-west corner of the area, east along the Pieman and Huskisson Rivers from 339,800 E to 352,000 E (see fig. 4). They were not examined by the writer.

Table II shows the interpretation of the stratigraphic succession in the area by various workers. Taylor's are the definitive descriptions, and these are summarized below.

Davey Group (Taylor, 1954).

This part of the succession has been placed in the Oonah Group by most other workers. It consists of micaceous sandstones and quartzites, with an "extreme variety of shales and slates". (p.20).

Taylor assigned the top of this group to the top of the pre-Cambrian, with an unconformity between it and the Success Group, on the following grounds.

"1. Its position below known Cambrian Group rocks.
2. Its unconformable relation to this group indicating a time interval.
3. The development of mica not significantly present in the succeeding groups.

	TAYLOR (1954)	BANKS (1956)	BLISSETT (1962)	CAMPANA & KING (1963) (Fig. 13)	SOLOMON (1964) (Fig. 8 & 9)
ORD.	Junee Gp.		Junee Gp.	Junee Gp.	Junee Gp.
	(Unconf.)		?	(Disconf.)	(Jukesian Orog.?)
CAMBRIAN	Huskisson Group	H. G.	H. G.	H. G.	H. G.
	(Serpentine)	(Serpentine)	(Serpentine)	(Serpentine)	(Serpentine)
	Crimson				C. C.
	Creek	C. C. A.	C. C. Formation	C. C. A.	mudstones
	Argillite				tuffs
		(Unconf.)			greywackes
				(Unconf.)	
	Success				
	Creek	S. C. G.			Success
	Group			S. C. G. =	Creek Phase
	(Unconf.)	(Unconf.)	Oonah	Oonah Group	
PROTEROZOIC			Group		
	Davey	Davey		(Unconf.)	(Penguin Orog.?)
				Older	Younger
	Group	Group		Precambrian	Precambrian
					(Frenchman Orogeny)
			(Unconf.)		
			Older Precambrian		Older Precambrian.

TABLE II

Interpretations of the succession along the Pieman and Huskisson Rivers.

4. The higher degree of contortion indicating that the group has experienced at least one orogeny before the deposition of the Cambrian sediments." (p. 21).

Points 1 and 2, as they stand, are respectively meaningless and tautologous. Point 3 has since been invalidated, as, for example, the overlying Renison Bell Sandstone is micaceous.

Point 4 would seem to be valid field observation, and must be accounted for. Blissett and Gulline (1961) explained it away by stressing that Taylor had not seen the Whyte Schist seven miles to the west, thus implying that the difference in deformation that he had described was insignificant. Campana and King (1963), and Solomon (1964), do not accord with this view.

Success Creek Group (Taylor, 1954).

On the Pieman, going east from 339,800 E to 343,500 E, the following succession is encountered:

- Thinly bedded grey shale to slate.
- Breccia with fragments of purple sandstone and white tuff; poorly sorted.
- Approximately 1200 ft. of massive quartzite; dark grey; coarsely bedded.

- Highly sheared, contorted and shattered shale.
- Alternating shales and quartzite.
- Thinly laminated quartzite.
- Grey to green shales with tuff bands.

The structure consists of gentle folds in the quartzites which often throw the shales into complex contortions.

Crimson Creek Argillites (Taylor, 1954) = Crimson Creek Formation (Blisset, 1962).

Taylor's type section runs from point 856,000 N - 345,300 E, along Crimson Creek, the Pieman River, and the Huskisson River, to point 858,000 N - 354,100 E. The stratigraphic thickness across this homoclinal series is 12,000 feet.

This formation possesses three most distinctive characteristics — its monotony in grain size, its degree of metamorphism, and its colour. The first is predominant fine grained siltstone; the second is that of an argillite, or indurated unlaminated conchoidally - fracturing argillaceous rock; the third is deep red to purple, with local variations (entirely of colour) to deep green. Taylor considers that 70% of the total thickness is purple argillite, and 20% green argillite. The remaining 10% consists of black shales, which in the upper part of the Huskisson River section are pyritic.

Taylor reports that the uppermost shales of the Success Creek Group show the incoming of pyroclastic material, and that the Crimson Creek siltstones are characterised throughout by bands with admixed pyroclastic material, which is a fourth distinctive characteristic.

There is one occurrence of a lava within the formation — a 30 ft.-thick flow of vesicular basalt, identified from thin section.

The structure of the type section is simple-homoclinal, but north along the Wilson River Taylor describes reversals of dip, which he tentatively ascribes to "very close folding along close spaced parallel nearly vertical planes". (p. 26). The writer is inclined to disbelieve this interpretation, as every reversal of dip in the Rosebery-Renison Bell succession that could be examined in section was due to slight overturning of nearly vertical beds, a very different style of folding (by 180° in apposed dip).

Huskisson Group (Taylor, 1954).

This correlate of the Dundas Group is separated from the Crimson Creek Formation along the type section by a fault-bounded serpentinite sill (according to Blissett, 1962).

The Group strikes about NW and dips vary between 35° and 80°, averaging 55°, to the NE. The stratigraphy of the group as originally worked out by Taylor, and as modified by Blissett, is illustrated in Table III.

4.3 Rosebery - Renison Bell Synclinorium

Because the major part of this succession is composed of the uniform Crimson Creek Formation, which has so far proved unfossiliferous, the delineation of its stratigraphy and structure has lagged behind that of the fossiliferous Dundas Group and its correlates, which overlie it.

The early workers in the area concentrated on examination of the ore deposits, at Rosebery, Colebrook Hill, the Exe River, and Renison Bell. Their geological descriptions and interpretations were biased towards the more tractable igneous rocks, and the succession now termed the Crimson Creek Formation was usually assigned by them to the "Dundas Slates" of Cambro-Ordovician age. (Ward, 1909, 1911; Conder, 1918; Hills, 1914, 1915a, b). Its structure was uncertain, but it was interpreted by Hills (1915a) as lying concordantly below the Mount Read Volcanics.

TABLE III - HUSKISSON GROUP STRATIGRAPHY

TAYLOR (1954)	BLISSETT (1962)
TOP Formation 19: 420' Breccia conglomerate	Equated formations 18 and 14, placing 15, 16, 17, and 19 in the overlying Mt. Zeehan (= Owen) Conglomerate.
18 : 420' Black shale	
17 : 130' f/g congl., ss.	
16 : 450' Cobble conglomerate	
15 : 120' Massive breccia, ss.	
14 : 110' Black graphitic slate	
13 : 890' Shale and tuff	
12 : 260' Pebble congl. & ss. & sh.	
11 : 610' Grey shale-slate	
10 : 90' Coarse tuff	Blissett confirmed this.
9 : 160' Shale	
8 : 160' Paraconglomerate (?)	
7 : 300' Shale with sandy layers	
6 : 350' Pebble congl./shale/congl./shale/congl.	
5 : 260' Massive shale	
4 : 170' Massive qtz. ss.	
3 : 390' Grey shale	
2 : 350' Qtzite./congl./shale/qtzite.	
1 : 380' Black shales. BOTTOM	
6020'	Not more than 4000'

In 1932 Finucane published a report on the geology of the Rosebery district in which he gave the name "Rosebery Series" to 5000-6000 feet of west-dipping "slates, quartzites and breccia-conglomerate" to the west of Rosebery. Taylor (1954) termed this series the Rosebery Group, and described it along the Pieman River and old road sections as extending from the serpentinite of Colebrook Hill, to about half a mile west of the Emu Bay Railway bridge across the Pieman Gorge. He considered all rocks on the other side (west) of the serpentinite to belong to his Crimson Creek Argillite.

Taylor's report clearly stated for the first time the problems in stratigraphy and structure raised by the Rosebery Group.

The Group dips west, whereas the Mount Read Volcanics immediately to the east dip east; and the boundary between the two formations is not clearly seen at any locality. This could perhaps be explained as a sharp but massive anticlinal structure, except that the beds along strike to the north of the Rosebery Group dip <u>east</u> under the Mount Read Volcanics, and this situation continues for many miles along the contact.

The easiest way to explain this is to postulate overturning of the steeply dipping Rosebery Group, and Hall et. al. (1953) suggested this on the basis of bedding-cleavage relationships. Taylor tentatively accepted this interpretation, and inserted an east-west fault between the two sectors, as he had found evidence of graded bedding giving normal attitude to the northern sector. M. Solomon, during field work early in 1964, has searched for any evidence of this fault without success. The beds north along the Emu Bay Railway show a gradual change of dip from steep west to vertical to steep east, in the space of a few hundred yards, and along strike.

Campana and King (1963), apparently noting the identical relationship, also considered the southern sector (Rosebery Group) to be overturned, due to drag along the shear that they postulated to offset the Rosebery and Hercules mines (the Jupiter Fault: fig.13). From regional evidence they interpreted an angular unconformity between the Rosebery Group and the overlying Crimson Creek Formation, and placed it to the east of the serpentinite, thus bringing some Crimson Creek across from the west, contrary to Taylor's interpretation.

After re-mapping a large part of the succession between Rosebery and Renison Bell, and mapping for the first time a new section to the south of the main road (diamond drill track NP 107), the writer has reached the following conclusions with respect to this problem:

(a) The Rosebery Group is definitely not overturned (Plates 7 and 14).

(b) The Rosebery Group is tentatively correlated with the Success Creek Group (or "Phase" - Solomon, 1964) at Renison Bell, and there, in agreement with Blissett (1962), Solomon (1962), and other workers, the writer considers the Crimson Creek Formation to be conformably overlying. Thus, although the Crimson Creek does indeed occur to the east of the serpentinite of Colebrook Hill (in agreement with Blissett (1962) and Campana and King (1963)), this correlation supports, and field evidence does not contradict, a conformable relationship between Rosebery Group and Crimson Creek.

The stratigraphic succession of the relatively simple synclinorium thus delineated is now described, in terms of a traverse from east to west, from the base of the Rosebery Group, to the Renison Bell Sandstones.

Localities mentioned will refer to the Specimen Locality Charts (fig. 22), while structures and general geology will relate to the Geological Plan (fig. 11).

4.31 THE ROSEBERY GROUP

4.311 Pieman River area

Campana and King (1963) have divided the Group into five formations.

East - Primrose (Footwall) Pyroclastics and Slate (4000 ft.)

- Stitt Quartzite (1800 ft.).
- Natone Volcanics (400 ft.) with a basal fuchsite breccia-conglomerate.

- Westcott Dolomitic Beds (300 ft.).

West - Munro Creek Slate and Quartzite (no thickness given).

- (Unconformity) -

- Crimson Creek Group.

The general revision of this sequence, as interpreted by the writer in the light of the reversal of attitude, is that the fuchsitic breccia-conglomerate is not basal to the Natone Volcanics, but to the overlying formation to the west, in which dolomites or dolomitic siltstones were not identified. The validity of the Westcott Formation is therefore also questioned.

The following descriptions will presuppose that west side is up.

The Stitt River section (C1-C17), from the E.B.R. bridge west, is as follows:

- Primrose Formation. As defined by Campana and King, C1 is in the upper portion of this formation, which supposedly extends across to the footwall of the Rosebery Mine. Although altered and sheared(?), tuffs were identified (31438, 31436?), and at one horizon, massive felsitic rock is identical with Campana and King's occurrence on the Primrose road, lower in the sequence. There are minor intercalations of black to grey sheared siltstone.

- A transition zone consists of green laminated siltstones (31441), tuffaceous fine-grained greywackes (31443), and fine grained, tuffaceous, pyritic, dark grey shales (31442).

31443, which dips east, is overturned, as grading in the coarser bands indicates a westerly facing, and the beds are overturned, not folded, in outcrop.

- The base of the Stitt Formation is above the dark grey shale. It consists of massive green tuffaceous greywacke, followed by massive grey saccharoidal micaceous sandstone (Plate 7), usually very fine-grained, which towards the top contains an increasing number of partings of dark grey and black shale.

Specimens 31447 and 31448 (Plate 8) are conclusive proof of the westerly facing of the homoclinal Stitt Quartzite. Several horizons, up to two inches thick, of festoon and simple current bedding, occur at the mouth of the Stitt River (inset in Locality Chart "C"). These dip west at an angle variable about 65°, and are truncated to the west, which is therefore the top.

Also at this locality there occurs a small-pebble conglomerate, containing rock fragments.

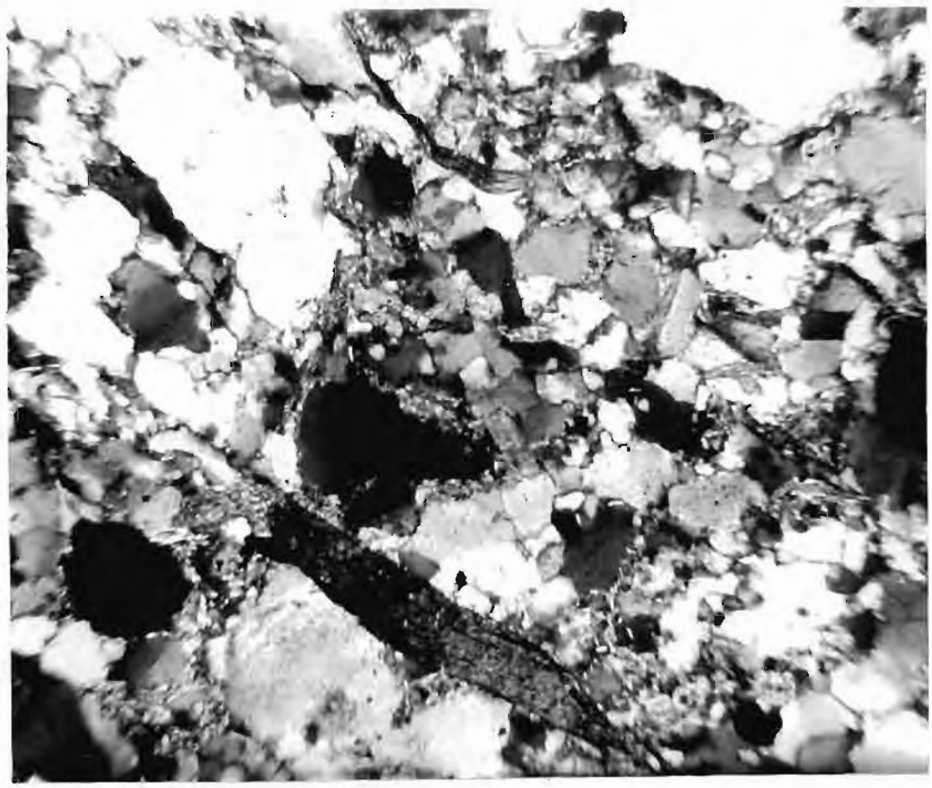


Plate 7.- 31449. Fine-grained micaceous sandstone, containing quartz grains, authigenic quartz and interstitial muscovite. Stitt Quartzite. Crossed nicols. (X92).

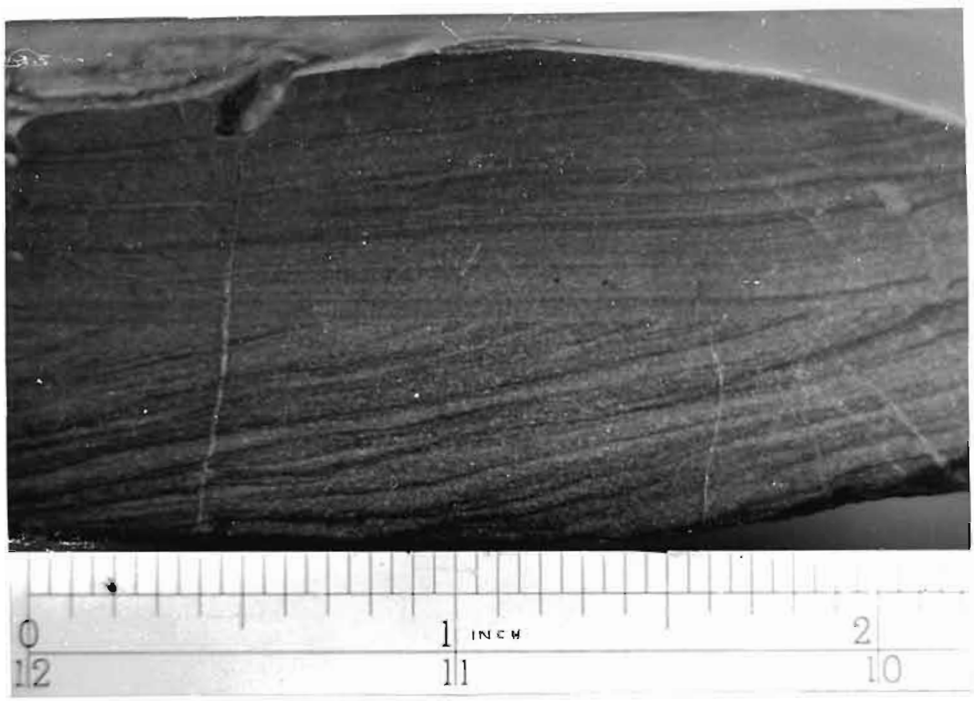


Plate 8.- Truncated cross-bedding at C14 at the mouth of the Stitt River. The photograph, the top of which is to the west, shows westerly-dipping, homoclinal Stitt Quartzite.

The road and river section west from the Rosebery Station flat (Campana and King's "heliport") commences with what appears to be the dark grey pyritic shale just below the Stitt Formation, which however, is not along strike from the Stitt River occurrence. The massive sandstone bars then appear in Chamberlain Creek, and on the gravel scrape immediately to the west. There is no sign of true ripple marks, as reported by Campana and King (1963, plate 1), although there are several thin (about 2 inch) horizons at C24 showing current bedding and intraformational slumping (?) in the sands of the closely interbedded sandstones and siltstones.

The topmost member of the Stitt Formation occurs on the railway, and on the big bend in the Pieman River. It is a greenish medium-grained felspatho-lithic greywacke.

The Natone Volcanics outcrop in the Pieman, railway and road (both old and new) sections (Plate 9). They have been petrographically described in Taylor (1954). The writer has examined eight slides of a section through the formation, and although some specimens could be sedimentary in origin (31486), as described by Campana and King, the bulk of the rock consists of altered rhyolites (e.g. 31484, 31485), indistinguishable from lavas in the Mount Read Volcanics (Plate 10). The vague outlines of several flows were seen on the river, but dips were very hard to determine, although they were probably vertical.

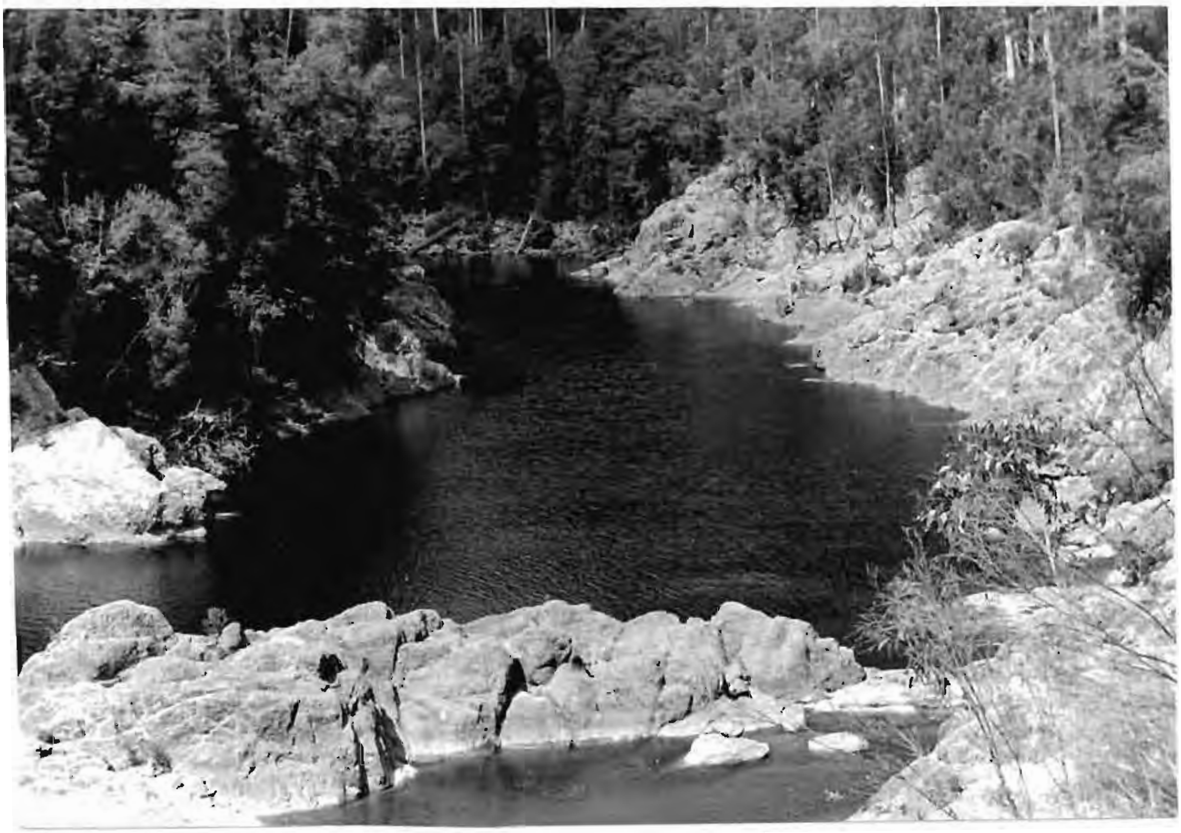


Plate 9.- The total outcrop of the Natone Volcanics in the Pieman River, looking east. At the furthest promontory occurs the contact with the Stitt Quartzite.

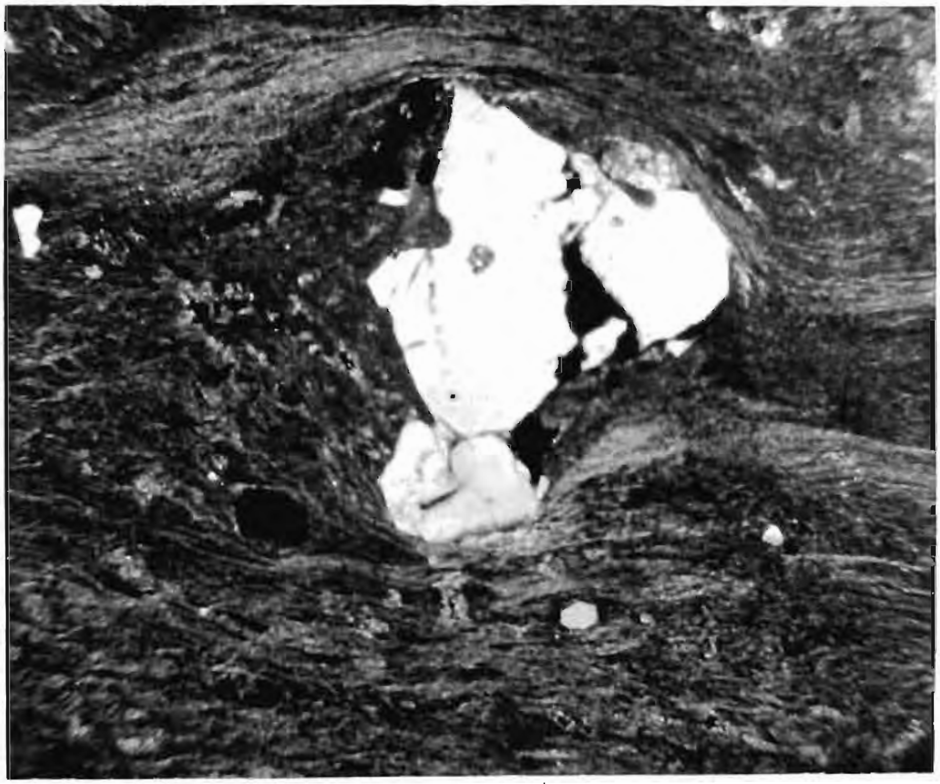


Plate 10.- 31484. Sheared rhyolite, showing quartz phenocryst in oriented, very fine-grained sericite matrix. Natone Volcanics. Crossed nicols. (X37).

The overlying <u>fuchsitic breccia-conglomerate</u> outcrops similarly to the volcanics. On the Pieman it shows strong vertical jointing, and the bedding is difficult to pick up (Plate 11). The rock is well described by Finucane (1932). It is usually poorly sorted with an open framework, but grades down to very fine grained sandstone locally. The fragments are subangular to rounded grains to cobbles of quartz, quartzite, chert, slate, tuff(?), and iron oxide. The matrix is composed of sub-angular detrital grains of quartz, felspar, chert, sericite and muscovite, carbonates, iron oxide, tourmaline and zircon (31490, 31492, 31493). Campana and King report chlorite, pyrite, chalcopyrite, galena and molybdenite, and Taylor (1954) quotes E.Z.Co., geologists as finding a small percentage of tin. The fuchsite, or chrome mica, occurs freely in discrete masses.

The texture of the rock is probably evidence for deformation, as the pebbles are markedly elongated in the direction of the jointing.

Campana and King report a chemical analysis of the rock with ($CaCO_3$ + $MgCO_3$ + $FeCO_3$) = 51.1%. No rock was seen with a carbonate content even approaching this. Some of the carbonate may be primary. Most of it, with the sericite and fuchsite, is probably secondary, as the sericitization and dolomitization is similar to that which has occurred in the Mt. Read volcanics, probably during mineralization.

Plate 11.- Vertical jointing (fracture cleavage?) in the fuchsitic breccia-conglomerate, Pieman River.

The Westcott Dolomitic Beds, reported by Campana and King, were not seen. The rock immediately above the breccia-conglomerate (31496) is a clean arenite, and X-ray analysis by M. Solomon (pers. comm.) revealed no trace of carbonate.

The outcrop for 400 yards to the west of this point is very poor. There is none on the Pieman and the railway, and very little on the road. However, at the old Colebrook Smelters, there occur partly laminated cream to light grey fine-grained siltstones, which show some drag folding (Plate 12). The bedding is $357^{o}/70^{o}$ W, while a typical fold, just discernible in the Plate, plunges $175^{o}/40^{o}$ S, with an axial-plane dip of 80^{o} E. These rocks may be considered as near the base of the Munro Creek Slate and Quartzite.

The main outcrop of the latter is the line C52-C69. On the road, alternating grey to black, pyritic (nodules and grains), micaceous shales are interbedded with subordinate massive, micaceous sandstone beds up to one foot thick (Plate 13). Campana and King report the black "slates" to assay 10% carbon.

Graded bedding is common in the coarser lutites, and although hand specimens only give indications of a westerly face (31509, 31510, 31513), slide 31406 (Plate 14) shows the grading to be quite distinctive. Thus the west-dipping Munro Creek Formation also has a normal attitude.

Plate 12.- Siltstone with bedding striking 345°, and dipping 70° west. The fold in the centre of the picture plunges 40° at an azimuth of 175°, and the axial plane dips east at 80°. At old Colebrook smelter. Munro Creek Slates and Quartzites ?.

Plate 13.- Interbedded micaceous sandstone and dark grey to black pyritic shales. Dipping west. Munro Creek Slates and Quartzites.

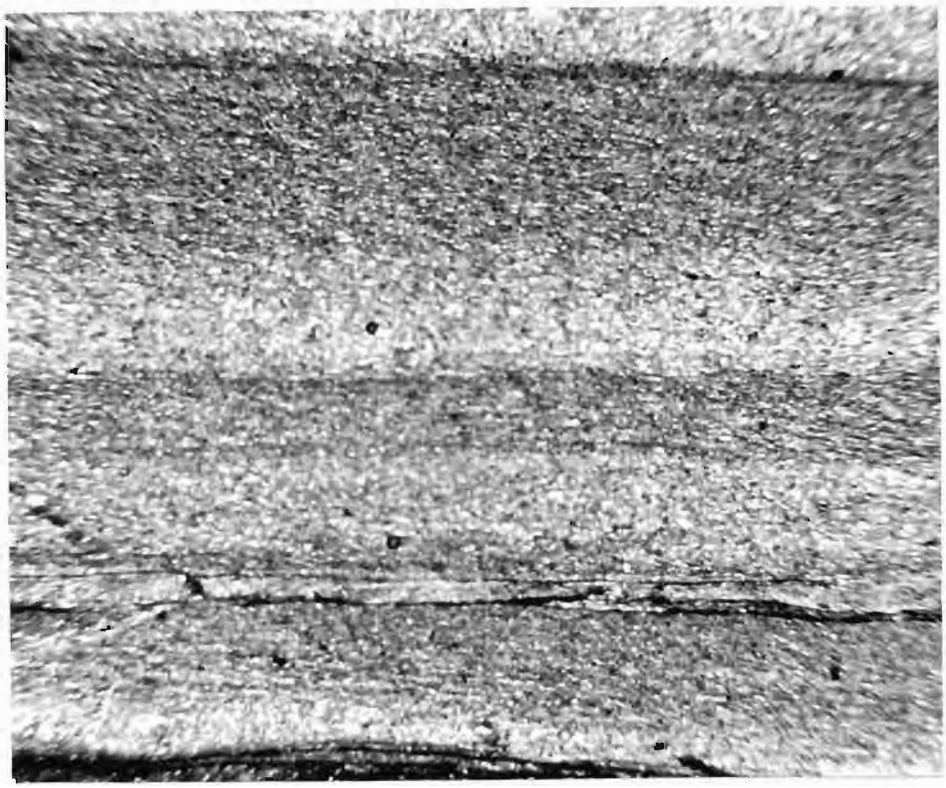


Plate 14.- 31506. Typical graded, coarse-grained argillite. The top of the photograph is to the west. The beds fine and dip to the west, giving a normal attitude. Munro Creek Slates and Quartzites. Crossed nicols. (X37).

On the river (C69), the topmost part of these beds — indurated micaceous sandstones and shales, include about 90 feet of discontinuous outcrop of an unusual series of small-scale folds, which are tighter than those at the Colebrook Smelters.

Examples:	Fold		Plunge	Axial Surface
	Anticline	Az.	$165^{\circ}/55^{\circ}$ S	St. $130^{\circ}/70^{\circ}$ S.W.
	Syncline		$176^{\circ}/45^{\circ}$ S	Vertical
	Syncline		$168^{\circ}/35^{\circ}$ S	Vertical
	Anticline		$345^{\circ}/10^{\circ}$ N	Vertical
	Anticline		$160^{\circ}/5^{\circ}$ S	Vertical
	Complex		$187^{\circ}/90^{\circ}$	Vertical
	Syncline		$163^{\circ}/0^{\circ}$	Vertical

Plates 15 and 16 are typical. The sandstone bands show fracture cleavage, the finer bands wrapping themselves less competently around the fold noses. Festoon and current cross-bedding in the sandstones indicate that some of the southerly-plunging folds may be upside down. Axial cleavage was very hard to find in these rocks, but the general impression is that these practically isoclinal folds are typical cleavage folds of an essentially superimposed shear zone.

Summary of stratigraphy

TOP Munro Creek Slate and Quartzite: about 1800 feet: micaceous sandstones and black micaceous shales.

Plate 15.- Folding at C69 on the Pieman River near the top of the Rosebery Group. South is towards the top of the photograph . Fold azimuth 155°, plunge 55°. The rule is six inches long.

Plate 16.- Folding at C69 on the Pieman River, near the top of the Rosebery Group. Left-hand anticline: azimuth 165°, plunge 55°; axial surface strikes 130°, dips 70° south-west. Right-hand syncline: azimuth 180°, plunge 75°; axial plane vertical. Ruler is six inches long.

Westcott Formation: about 300 feet: no dolomites were seen: siltstones overlying clean sandstones; may be the top part of a cycle initiated by the breccia-conglomerate.

Fuchsitic Breccia-Conglomerate: about 80 feet: a paraconglomerate (Pettijohn, 1957).

Natone Volcanics: about 400 feet: altered rhyolites and acid tuffs.

Stitt Quartzite: 1800 feet: micaceous sandstones and siltstones, with minor grits and pebble conglomerates.

Primrose (Footwall) Pyroclastics and Slate: 4000 feet: tuffs, pyritic shales, siltstones, and lavas (?).

4.312 Diamond drill track NP 107

This track (figs. 12 and 22D) leaves the Rosebery-Williamsford road at the Rosebery Cemetery, crosses Natone Creek, and winds in a westerly direction along the southern slopes of Westcott Hill. Outcrop on the track represents the only good rock exposures in a very large area west of the road — an area important for an interpretation of the regional structure. Nevertheless, the outcrop is fortunately placed, in that it brings known Rosebery Group rocks far enough south to enable the construction of a more realistic fault system than hitherto possible.

The only outcrop on the moraine-covered eastern bank of Natone Creek is 200 feet up the track from the ford, and consists of

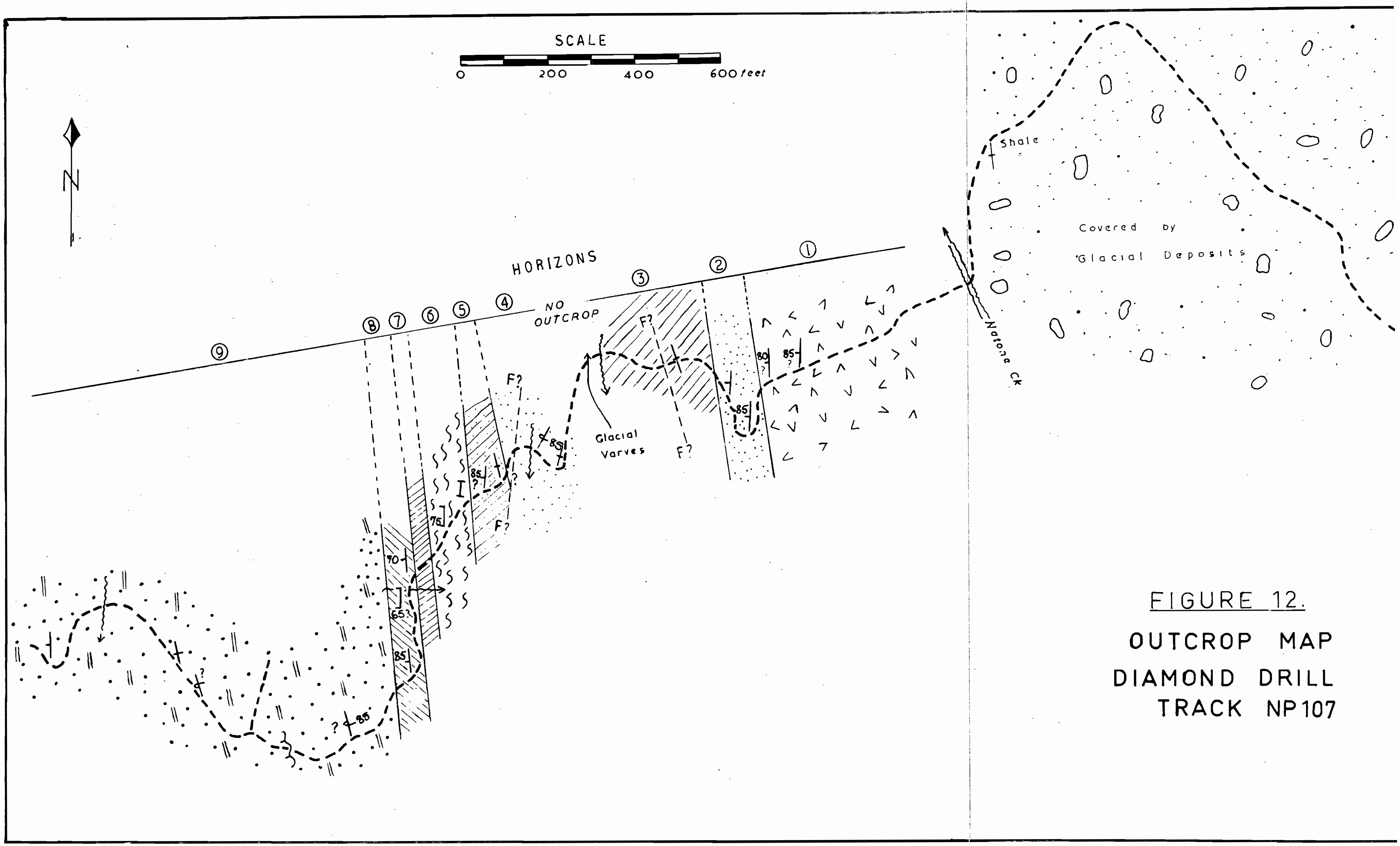


FIGURE 12.

OUTCROP MAP
DIAMOND DRILL
TRACK NP107

weathered, dirty cream, very fissile shales, with some coarser (tuffaceous?) bands up to $\frac{1}{4}$ in. thick.

West of the creek, nine main horizons were encountered. These are marked on figure 12, together with the discoverable attitudes.

Horizon 1 consists of Mt. Read Volcanics. Specimen 31451 is an altered rhyolite, with shattered and drawn-out quartz phenocrysts in a sericite groundmass. Other specimens from this horizon resemble felspathic tuffs. Identification of bedding was uncertain.

Horizon 2 is composed of laminated, grey, very fine-grained greywacke, and medium grained to coarse grained quartzose to micaceous lithic sublabile greywacke (32100).

Horizon 3 is a series of heavily chlorite-veined purple and green dense micaceous siltstone, with very few finer partings. Further west, bright red, weathered, very fine sandstone or siltstone shows no bedding traces at all.

Horizon 4 consists predominantly of sheared, micaceous, coarse sandstone, and lithic greywacke (31457), with intercalated khaki and purple weathered siltstones.

Horizon 5 is a very fine, dark grey, micaceous siltstone containing indeterminate pellets (31458).

Horizon 6 is a graphite schist (31460), with nodular and lenticular inclusions of sandstone (31461). The schistosity becomes less marked towards the top of the horizon, which passes up into the light grey shale (31462) of horizon 7.

Horizon 8 is a distinctive, dark grey, relatively sparsely laminated, indurated, very fissile shale or argillite. This is succeeded by horizon 9, with micaceous sandstones interbedded with light and dark grey laminated and unlaminated siltstones. Specimen 31466 shows the westerly dip to be a normal attitude, with current bedding truncated to the west.

Should horizon 9 (and probably several of the horizons beneath it) be correlated with the Munro Creek Slate and Quartzite, or with the Stitt Quartzite?

The Stitt correlation is favoured by the absence from the section of the fuchsitic breccia-conglomerate. It is not favoured by the dissimilarity between the rocks of horizons 2 to 7, and the transition zone beneath the Stitt Quartzite. However persistence of such rapid facies variations laterally for a distance of $1\frac{3}{4}$ miles might not be expected.

The Munro Creek is favoured by its proximity (more nearly along strike), and by the absence from horizon 9 of the massive bars of sandstone found in the Stitt Quartzite. In addition, photo-interpretation suggests that the breccia-conglomerate swings in outcrop slightly to the south-west, which would bring the stratigraphic horizon of the Natone Volcanics closer to that of horizon 1.

Assuming, then, that the upper part of the traverse is the Munro Creek Slate and Quartzite, the absence of the breccia-conglomerate must be accounted for. The only reasonable explanation is that over a distance of $\frac{3}{4}$ mile it has lensed out, and has been replaced laterally by a very fine to coarse greywacke horizon. If this is a correct interpretation, Campana and King's (1963) use of the breccia-conglomerate as a marker horizon over a meridional distance of about 10 miles (fig. 13) is not warranted.

The second consequence of this interpretation is that, in agreement with structures in the Munro Creek Formation, easterly dips are overturns, and westerly dips normal. Therefore the probably westerly dips in the horizon 1 tuffs and lavas are normal, and their affinities must be with the Natone Volcanics. Thus their structural relationship to the east dipping (75^{0}) massive Mt. Read Volcanic sequence on the main road only $\frac{1}{4}$ mile to the south east demands elucidation, because the two horizons converge in strike.

The slight southwesterly swing of the outcrop of the breccia conglomerate (by inference), and the top of the Natone Volcanics (by interpretation of observation) is not due to a change of strike between the Pieman River and the traverse to the south, and must therefore be due either to transgression of facies across strike, with slight thinning, or to faulting. In any event, the east- and west-dipping volcanics do converge in strike, and an intervening fault seems indispensible.

This southern traverse across the top of the Rosebery Group shows that, whatever the validity of the above assumptions and correlations, there is marked lateral variation of rock types within the Group, which helps not at all the correlation and/or extension of the Group to the north and south, so necessary for any structural interpretation.

Another feature is that the degree of alteration and physical deformation is greater that in the type section of the group. The schisted graphitic siltstone is the outstanding example, probably implying some differential movement, not necessarily of large magnitude, between adjoining blocks, which was lubricated by this soft sediment. Apart from this, however, the rocks are noticeably more faulted, shattered, quartz-chlorite veined, and boudinaged (in horizons 6 and 9).

Summary. Horizon 1 is correlated with the Natone Volcanics rather than the Primrose Pyroclastics and Slates. Horizon 2 may be a lateral equivalent of the fuchsitic breccia-conglomerate. The remaining horizons are probably correlates of part of the Munro Creek Slates and Quartzites.

Rosebery Group - Discussion. It has been suggested (A. Spry - pers. comm.) that the repetition of the sandstone-siltstone facies from the Stitt Quartzite to the Munro Creek Slates and Quartzites is an improbable event stratigraphically, and that the sequence sandstone-siltstone, siltstone, conglomerate, and volcanics, has been duplicated by dip-slip strike, or oblique faulting.

The field evidence indicates no such faulted repetition. The sequence is interpreted as representing the interdigitation of lenses of the easternmost extremity of the Success Creek Group with a thin tapering lense (Natone Volcanics) of the Mount Read Volcanics, thrusting west from a low, but indeterminate level in the volcanic pile.

4.32 CRIMSON CREEK FORMATION

This was examined from the top of the Rosebery Group west along the Pieman River, the Emu Bay Railway, and the road, to the Exe River; in the Exe River between the E.B.R. and the road; thence westwards along the road to Renison Bell. (Fig. 11).

This succession was mapped by Taylor (1954) and by Blissett (1962), the latter drawing extensively from the former's results. The overall structure they derived is indicated in figure 4.

The writer could find no marker horizons in the Crimson Creek Formation, although certain rock-types were repeated with remarkable consistency of lithology. Further, the sequence from the top of the Rosebery Group to Colebrook Creek has been folded and faulted, and a measured stratigraphic sequence cannot be described. The lithology across this part of the traverse will therefore be presented piecemeals, in geographic succession from east to west. From Colebrook Creek to Renison Bell, the succession will be described in stratigraphic order.

The top of the Rosebery Group occurs on the Pieman River, between the mouths of Munro Creek and Josephine Creek (the next creek to the west), and probably not far from the latter, just above the folded zone of Plates 15 and 16.

Halfway between C69 and E1, occurs a massive blue-grey fine-grained sandstone (31521), which probably represents the top of the Rosebery Group. The succeeding sequence from there to the serpentine is structurally cryptic. Bedding was extremely difficult to pick up, and where discernible, was either vertical, or dipping no more than an absolute maximum of 15° either side (i.e. east and west) of this — more often only about 5° either side. With no definite marker horizons, the structure is therefore not known with certainty. Westerly dips, however, are probably normal, as at 354,300 E, on the north bank of the river, current bedding dipping west was truncated to the west.

Easterly dips present a problem. Taylor has interpreted a simple syncline across the Rosebery Group — Colebrook Hill Serpentinite succession, with its N-S axis running through the mouth of Josephine Creek. The writer's mapping, despite the paucity of reliable dips, has not substantiated this. Westerly dips have been discovered to within 20 chains of the serpentinite, the last sector probably being folded into a syncline, and possibly another complete fold as well.

On this evidence, it is tentatively concluded that easterly dips to within 20 chains of the serpentinite are overturns (none shallower than 85° E), and within the last 20 chains, probably represent normal bedding (e.g. 73°E).

The traversed succession west from the blue-grey sandstone (XI), disregarding structure, is as follows: (The "X" series will be used to index described members) :

X2 - Massive purple argillite (31522). This is a typical Crimson Creek Formation lithology, identical to that exposed (in what is a very useful reference outcrop) in the cutting on the main road immediately east of

Colebrook Creek.

X3 - Banded sandstone (31523).

X4 - Blue-grey and purple argillites.

X5 - Blue-grey sandstone, slightly micaceous.

X6 - Laminated fine-grained sandstone. Truncated current bedding gives a normal westerly dip.

X7 - Laminated lithic greywacke (these are Taylor's "tuffs").

X8 - Massive blue-grey sandstone.

X9 - Felspatho-lithic (?) greywacke, and argillite, (31524).

X10 - Lithic sublabile greywacke, with clear quartz fragments.

X11 - Finely bedded very compact black shales.

X12 - Light grey medium grained greywacke. (Also 31527, Plate 17).

X13 - About 500 feet of rock described by Taylor, after petrological examination, as a chlorite sericite schist.

X14 - Hard against the serpentinite, the rock appears to be a laminated siltstone (31543).

- Serpentinite.

This succession is a mixture of rocks similar both to those of the Success Creek Group, and those of the Crimson Creek Formation proper. Thus interdigitating or interbedding of these two series appears to have occurred roughly at the same meridional position in the depositional basin as the interlensing of the Natone Volcanics and the

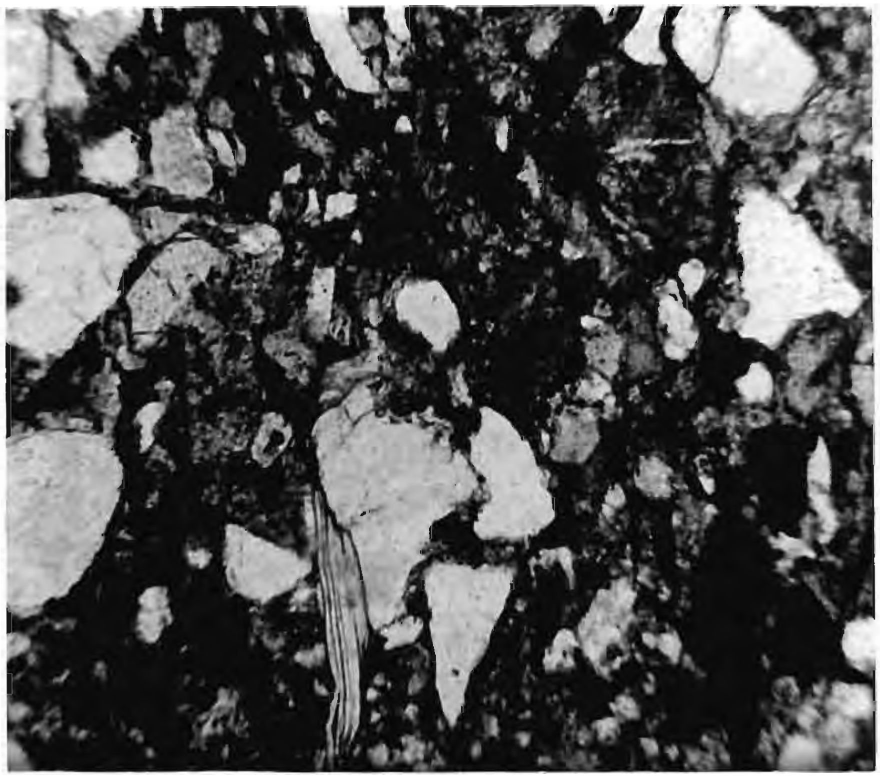


Plate 17 .- 31527. Very poorly sorted fine- to medium--grained sublabile greywacke, containing quartz, muscovite and haematite in a fine groundmass of quartz, chlorite and ferriferous material. Crimson Creek Formation. Plane polarised light. (X92).

Success Creek Group, but at a higher level in the succession. Neither the discernible structure nor the detailed rock sequence suggests that the repetition is due to folding.

The only good exposures in the "Y" of the serpentinite are in the Pieman and along the E.B.R. This is a much more deformed zone, and although folds have been interpreted and plotted (fig.11) the absence of marker beds makes verification of structures impossible. However, only those structures which could be directly traced in the field around their change of attitude are plotted on the map. The other strikes and dips could not be satisfactorily interpreted.

Another difficulty arises in the disparity of attitudes between the folded rocks in the river section, and those in the E.B.R. section, in which only westerly-dipping rocks were seen. The latter phenomenon could be a coincidence, as it is just possible to join up the structures in the two traverses.

Overall, the widest homoclinal successions, limited though they are, dip west, suggesting that the axis of the synclinorium is towards the western end of the traverse.

The plunges of the folds does not seem to exceed 45°, to both north and south, which implies cross-folding and/or faulting, the latter being the more likely alternative.

The traversed succession west from the Colebrook Hill serpentinite, disregarding structure, is as follows:

X15 - At E10 and E13, the rock seems to have been affected by the intrusive serpentinite. Specimen 31531 is a micaceous hornfels (?) while the country rock at E13 is highly cleaved, the cleavage planes dipping towards the serpentinite, and filled with fine, closely spaced quartz veins (31532).

X16 - In the river, the rock adjoining the serpentinite is a bedded and massive tuffaceous sandstone or felspatho-lithic greywacke horizon (31544).

X17 - Pyritic carbonaceous (?) shales, with greywacke intercalations.

X18 - Dark grey shales and siltstones with very fine tuff or greywacke partings, with overlying massive greywacke and greywacke grits.

X19 - Light grey fissile siltstone.

X20 - Banded argillites.

X21 - Purple argillite and greywacke.

X22 - Dark blue-grey argillite and greywacke.

X23 - E.B.R. section: massive, unlaminated, khaki, brown to cream shales and greywacke grits, with fragments of included sediment. (31538).

X24 - Greywacke and massive, hard, purple-grey shale. (31542).

X25 - River section: purple and green-grey argillites and purple lithic greywacke.

X26 - At E26, 31545 shows truncated festoon cross-bedding in a massive, purple, very fine-grained greywacke, or argillite, which dips normally to the south at 20°.

X27 - Medium-grained lithic sublabile greywacke, with prominent quartz fragments.

X28 - Northern bank of the river: highly fractured in part, but mainly massive, quartzose sublabile greywacke (31547).

X29 - Indurated, fine-grained siltstone.

Horizons X27 and X28 are repeated by a series of folds around E28, east of the mouth of the Exe River.

X30 - Southern bank of the river: mineralized (pyritic), sheared, greywacke and siltstone.

X31 - Mouth of the Exe River: grey, pellety greywacke and very finely laminated shale.

X32 - On the road at E16, there is a recurrence of the distinctive banded purple argillite, with felspathic (?) greywacke (31537).

All of these rocks are typical of the Crimson Creek Formation. Horizons X11 and X17 correspond to the pyritic black shales described by Taylor, but these occur right throughout his type section, and are therefore useless as marker beds. Thus it is impossible to determine the stratigraphic level of this folded section with respect to the type section,because there is no structural conformity. Not only is there an intervening serpentinite, but it is heavily faulted.

Because of these difficulties, the position of the axis of the Rosebery-Renison Bell synclinorium can only be inferred. Blissett mapped the Huskisson Syncline to the north as plunging away from the centre of the serpentinite "Y", but there must be an east-west fault separating the Syncline from the river section, which, because of the displacement of the Huskisson River serpentinite, may have a sinistral transcurrent component to its predominantly north-side-down movement. A resulting easterly displacement of the southerly continuation of the Hus$kisson Syncline axis is problematical.

The last part of the section is along the road from the gabbro at the Exe River to the Success Creek Group at Renison Bell.

At the Exe River, the faulting and folding associated with the Dundas - Meredith Range belt of ultrabasics has thrown the rocks into complex and indecipherable attitudes, especially along the Exe River to the Pieman. Away from this area, the folding dies out, and the formation climbs up steeply towards the Renison Bell anticline, from the top of which it has been stripped.

The outcrop in this section is far from continuous, and no meaningful sections could be measured. A generalized succession will therefore be described, with reference to the 21 cuttings in the road section (annotated 1 - 21 on fig. 11).

<u>Cutting 1</u>. The structure here is complex, probably due to the faulting which truncates the Exe River gabbro. It may be interpreted as a small, open, southerly-plunging anticline.

X33 - The rocks are highly weathered siltstones and greywackes (31550, 31552, 31556), with a quartz-veined, sheared, small-pebble conglomerate. At the eastern end of the outcrop, in the bed of the river, lead-grey massive argillites show pyrite mineralization.

<u>Cutting 2</u>. X34 - Outcrop in the creek at the eastern end of this cutting displayed carbonaceous(?) siltstones with fawn silty partings.

The cutting itself has a complex structure (fig. 14). The altered basic igneous rock (plate 18), described from here for the first time, is probably a doleritic differentiate of the nearby gabbro. The texture is too coarse, the felspars probably too calcic, and the field relations a little too discordant for the rock to be an interbedded spilite. Plate 19 is typical of many rocks in the Crimson Creek Formation, with ubiquitous plagioclase felspar, and spilite(?) and quartzite rock fragments. The quartz is unstrained, though cracked, but could not be definitely identified as volcanic. Orthoclase is also tentatively identified.

<u>Cutting 3</u>. X39 - The outcrop here was quite indecipherable, both in the field, and in thin-section analysis (31579), although the

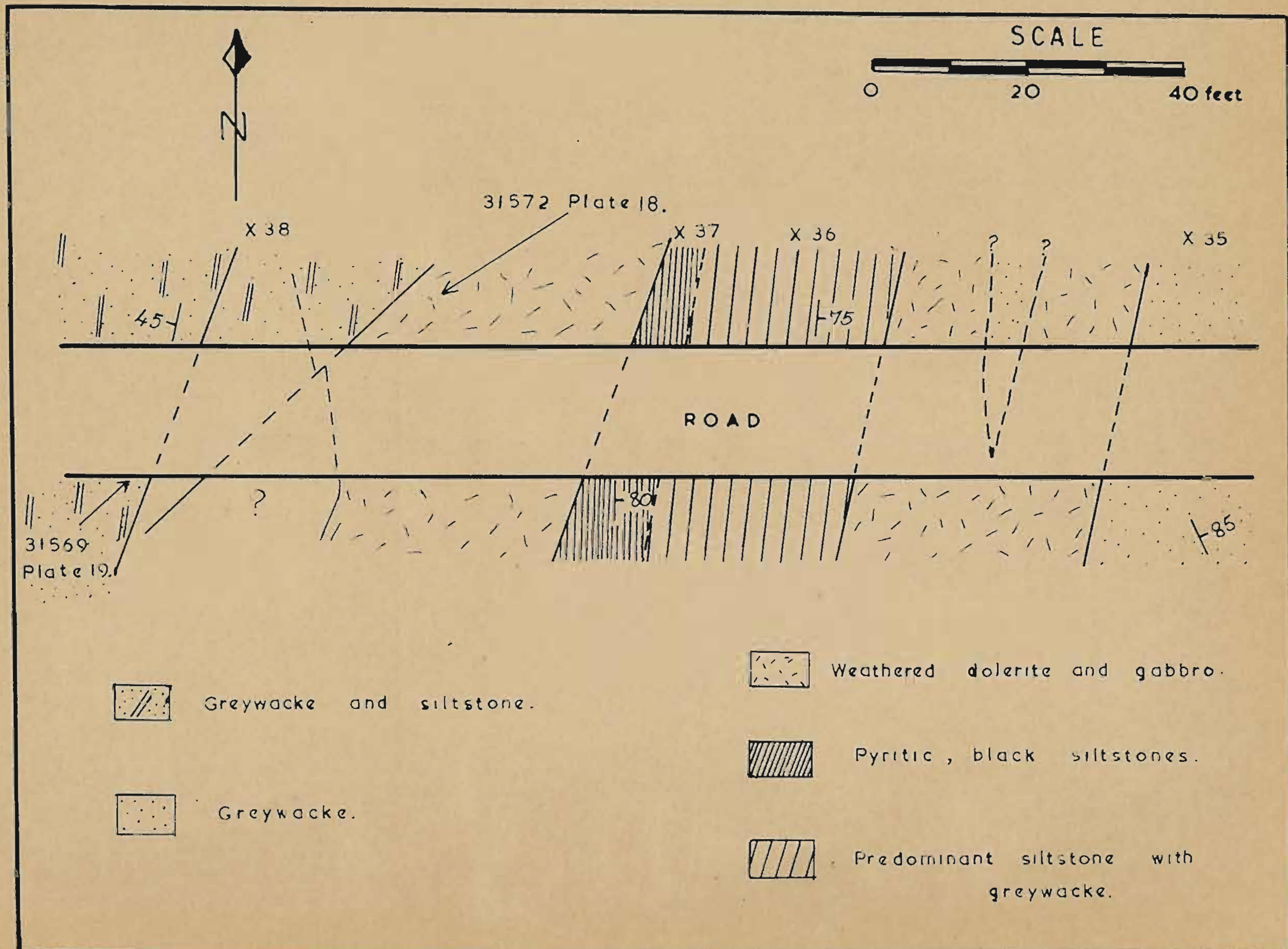


Figure. 14.
Geology, Cutting 2, west of Exe River.

Plate 18 .- 31572. Altered dolerite (intruding Crimson Creek Formation), showing plagioclase laths (white) enclosed in serpentinised pyroxene(dark grey), with black penninite and iron oxides. Crossed nicols. (X37).

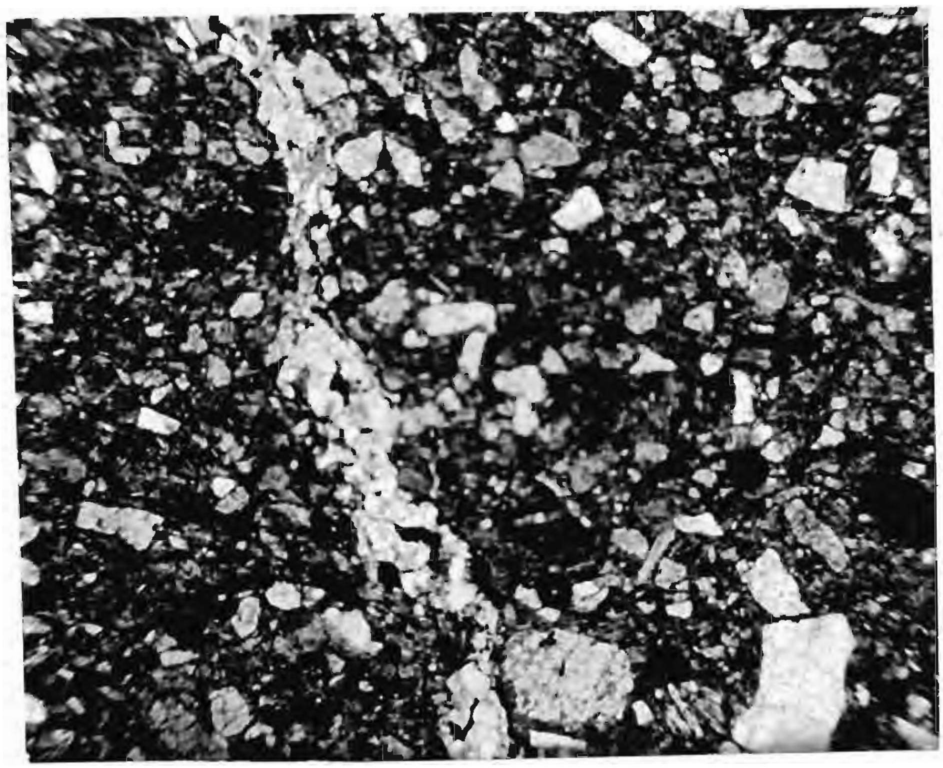


Plate 19.- 31569. Fine-grained, litho-feldspathic labile greywacke, showing quartz (greyish-white) and unaltered plagioclase (white), with a cross-cutting quartz vein. This rock also contains fragments of spilite(?) and quartzite. The cementing material is kaolin, with iron--ore and chlorite. Crimson Creek Formation. Plane--polarised light. (X37).

latter specimen may contain devitrified volcanic glass.

Cutting 4. X40 - Dark grey flinty argillites and light blue-grey greywackes and siltstones dip predominantly to the south-east.

Cutting 5. X41 - Irregularly lensing grey siltstone and greywacke, with much small-scale faulting. East dipping.

X42 - West of a north-south fault: west dipping purple greywacke containing shredded, purple, very fine-grained siltstone fragments.

Cutting 6. X43 - A series of easterly-dipping interbedded coarsely laminated (down to ¼ in.) dark and light grey, and purple greywackes and siltstones.

Cutting 7. There is some folding or overturning at the western end. This is the top of the "reference section", consisting of typical purple and green (= slightly weathered purple?) greywackes and greywacke grits, and laminated siltstones (X44).

Cutting 8. This contains the uniformly east-dipping reference section (X44). Plate 20 shows the typical medium-grained, fairly poorly sorted lithic greywacke. The siltstones, which constitute about 50% of the section, are often very finely laminated, and are very fine grained, being difficult to resolve with the microscope even under high power. (31584, 31586, 31593, 31595).

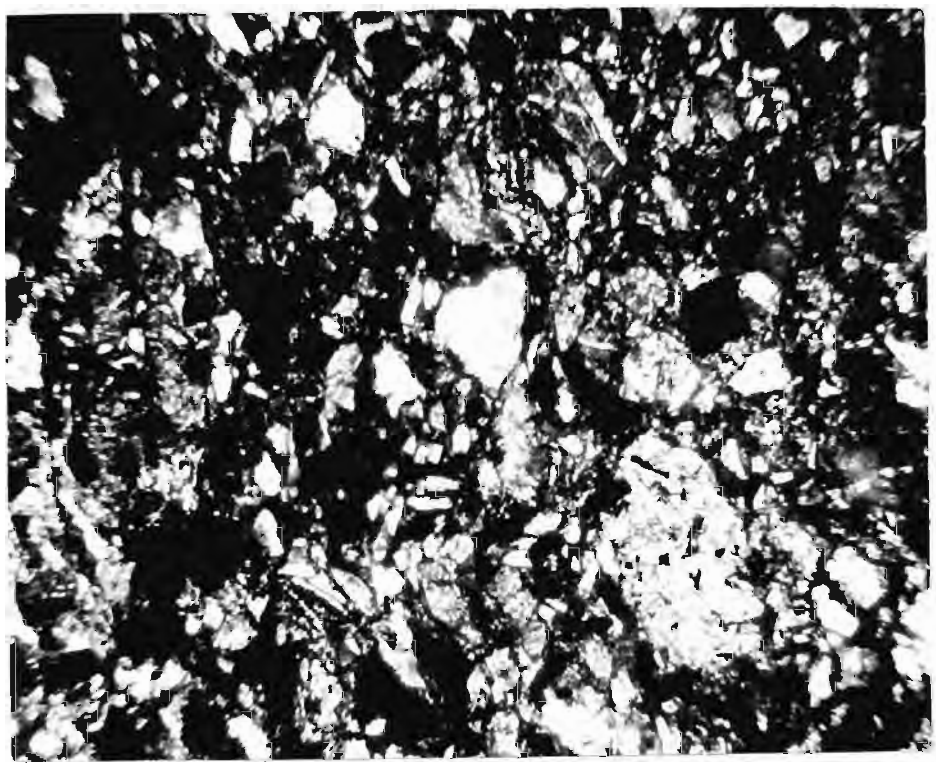


Plate 20 .- 31592. Medium-grained lithic, labile greywacke from a typical purple greywacke-argillite lithological horizon in the Crimson Creek Formation. Fragments include quartz and quartzite (white), chert and plagioclase (grey) , and altered spilite(?) (with small feldspar laths), with chlorite and haematite (black) in the groundmass. Plane-polarised light. (X92).

The "laminations" are sometimes due to a change of grain size, but more often are simple colour banding parallel to bedding, of uncertain origin.

Specimen 31593 is typical of many beds. The purple shale has been shredded into rounded, elongate fragments up to ½ in. long, which are usually aligned, parallel to bedding, in the lithic greywacke. A variation of this is the partial curling-up of minute slivers of the top of a siltstone band into the overlying greywacke band, giving an east-side-up normal attitude (which is confirmed by graded bedding at this locality).

<u>Cutting 9</u>. Consists of a faulted syncline plunging at about 60° SE.

X45 - Weathered, green, greywacke and siltstone.

<u>Cutting 10</u>. Overturned dips to the west, of down to 80°, occur here. Multicoloured, fine-grained greywackes and siltstones similar to X45 are rapidly repeated over a thickness of about 350 feet. All the rocks are weathered, to khaki, olive green, light grey, white, and a very distinctive rouge pink (siltstone), depending on the iron and labile content, and the degree of weathering (31598, 31599, 31600, 31601). The rouge pink lithology repeats six times in 150 feet.

<u>Cutting 11</u>: Small, very tight drag folds were interpreted from dips mapped here. These plunge south at a shallow angle.

X45 lithology is replaced by a finer version of X44, which is fissile and flinty (31602, 31603, 31604). Although the finer rocks are extremely ferruginous, the coarser fractions are not, implying a pre-depositional winnowing-out of this material.

Cutting 12. The multicoloured greywacke-siltstone horizon X45 now repeats. At the western end, a 22 foot thick saussuritized gabbro outcrops. This is followed in cutting 13 by white and mustard siltstones and felspathic greywacke, some of the latter containing pellets of siltstone (?) up to $\frac{3}{8}$ in. in diameter.

Cutting 14, the large excavation north of the Ring River bridge, reveals a uniformly east-dipping sequence of X45 material, and several horizons of X46, a coarse grained, felspatho-lithic greywacke, with large grains of clear quartz, and many volcanic rock and mineral fragments (Plate 21).

The complex Ring River bridge area is illustrated in figure 15. The dolerite (31615) appears to be a fine-grained differentiate of the gabbro (31616), the field relations of which are inconclusive with respect to the mode of emplacement. Blissett's mapping (fig. 4) suggests a sill relationship. The discontinuity of the dolerite outcrop in fig. 15 is a function of relief; the road is 35 feet above the river at the bridge. The dolerite therefore probably dips west, against the dip of the country rock, and could therefore be termed a dyke. The top of the dyke occurs below the top of the road cutting, so that its areal extent is quite limited.

Cutting 15. The succession proceeding west is X46; X44; X45; X44; X45; and X44. Graded bedding gives a normal easterly dip.

Cutting 16 reveals a southerly continuation of the Ring River

Plate 21 .- 31613. Coarse-grained, feldspatho-lithic labile greywacke. Rock fragments include quartzite (light grey), chert, and some basalt(grey). The mineral fragments consist of quartz (white), sericitised feldspar (cloudy) and muscovite. Some augite is present, partly altered to hornblende. The matrix contains chlorite, kaolin, fine quartz and iron-ore with some leucoxenisation. Crimson Creek Formation. Plane-polarised light. (X37).

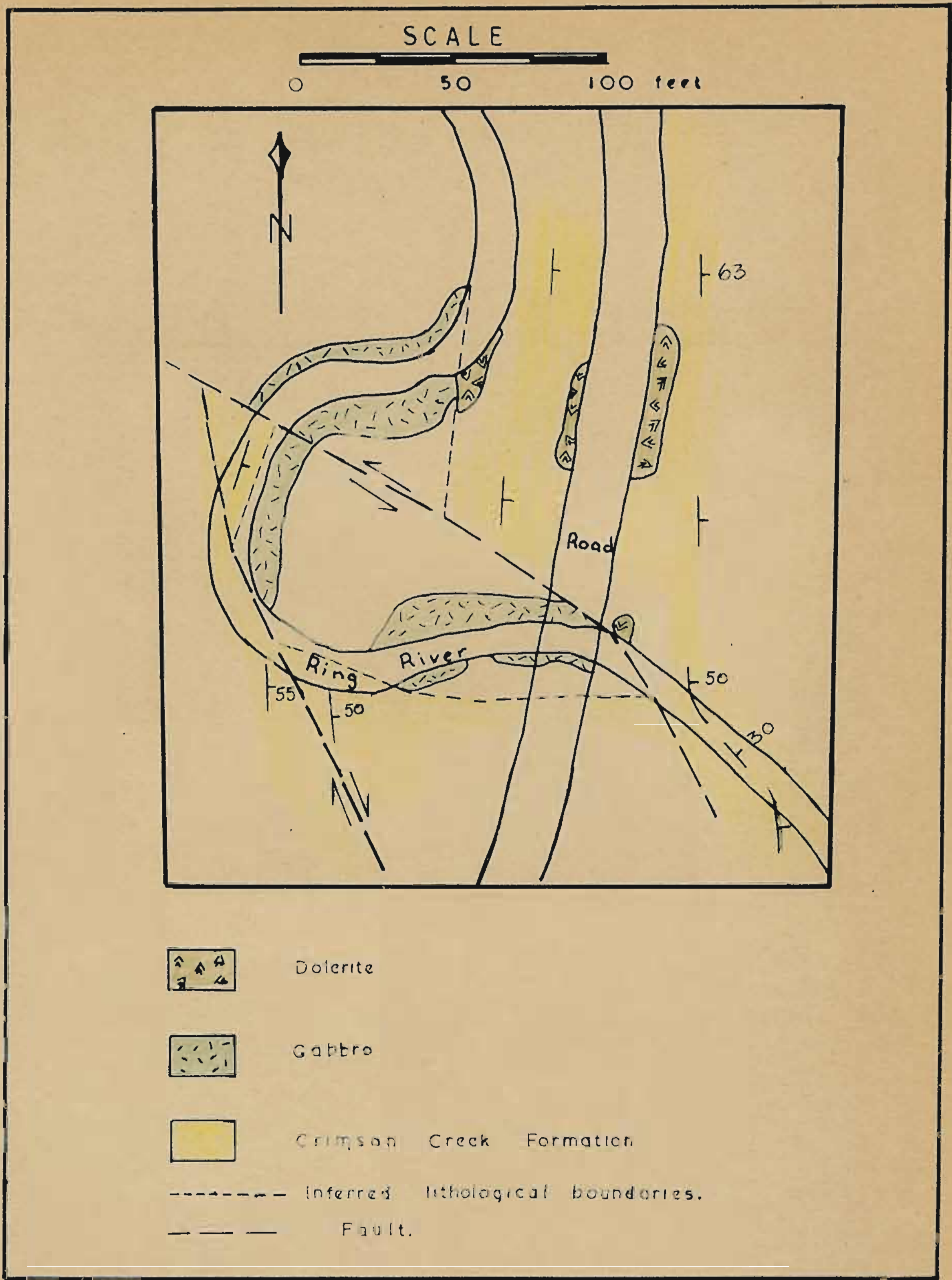


Figure 15.

Geology at Ring River Bridge, on Rosebery-Renison Bell road.

gabbro. X44 siltstones are interbedded with very poorly sorted, coarse-grained lithic greywacke (X47).

Cutting 17 gives a succession of X45; X47; X40; and X45.

Cuttings 18 and 19 reveal a coarsening of the greywacke up to pebble conglomerate size, with siltstone fragments up to $\frac{1}{4}$ in. in diameter. This is underlain in cutting 20 by X45; 31627 - a dark grey, flinty, fine-grained lithic sub-labile greywacke; 31626 - a medium grained felspathic greywacke; and X40; and then, in cutting 21, by dark grey laminated shales (X48) very similar to those in the Success Creek Group; massive micaceous greywacke; X40; and X45.

There is then a gap in outcrop along the road until the base of the Crimson Creek Formation is reached. This consists of 80 feet of the thin and lenticular "Red Rock" of Conder (1918), of red chert, quartz grit and conglomerate, with a distinctive horizon containing septarian nodules — spherical concretion-like structures a few inches in diameter with both radial and spherical fractures, which are sometimes filled with vein quartz.

Crimson Creek Formation Stratigraphy - Summary

(a) The various lithologies are always very limited in thickness, and are repetitive in most cases.

(b) There appears to be no significant areal differentiation of grain size in the east-west direction across the traversed succession. It is true that towards the western base, around cutting 18, ill-sorted pebble greywacke-conglomerates, and greywacke grits, proliferate. Further, the basal conglomeratic series is distinctive. But Blissett (1962, p. 27) reports that about $\frac{1}{4}$ mile west of the mouth of the Ring River, thin bands of coarse conglomerate outcrop. They contain rounded pebbles of quartzite, schist and tuff(?) up to six inches in diameter. Not only is Blissett's occurrence half way up the type succession but, as with similar lithologies in the Dundas Group, it is probably impersistent.

On the other end of the grain-size scale, the distribution of pyritic black shales throughout the sequence is as random as in Taylor's (1954) type section: there is no preference shown for particular levels, insofar as "levels" can be represented in a succession without marker horizons.

(c) Arenites containing a significant amount of mica are found only at the eastern and western extremities of the formation outcrop.

(d) It is tentatively concluded, on the basis of estimates of the position of the synclinorial axis, and of the style of folding, that the Formation thins from west to east to about one quarter of its thickness in the type section, that is, to about 3000 feet. However as the structural and stratigraphic interrelation of the Formation and the Rosebery Group is at present not known, this estimate, based on outcrop thicknesses, must remain a minimum. Sub-surface interdigitation could be the dominant variable.

(e) No conclusions could be reached concerning depositing-current directions.

(f) In confirmation of all other work, the writer found no fossils. The only rock that even suggested their preservation was 31551-5, a ferruginous very fine grained greywacke, containing oval nodules with a suggestion of radiating structure. The rock is too weathered to enable detailed examination.

5 IGNEOUS ACTIVITY

A: Extrusive and Pyroclastic

Carbine Group - Dundas Group

There is no record of lavas or tuffs in the Carbine Group. The Crimson Creek Formation seems likewise barren, except that rocks at Moore's Pimple, which Blissett assigns to this Formation, have been correlated by Campana and King with the Rosebery Group, which includes acid volcanics. The resolution of this apparent disagreement could be that part of the Crimson Creek Formation, and the Rosebery Group, are at the same stratigraphic level.

In agreement with Banks (1962) and Campana and King (1963), the writer agrees that many of the tuffs described by Elliston are lithic greywackes. However there is a tuff at the base of the Brewery Junction Formation; and the Curtin Davis Volcanics (picrite basalts), to the north of the type area, occur at the same horizon. Elliston (1954) has also reported a more vesicular and scoriaceous flow on the North-east Dundas Tram, at the horizon of the Hodge Slate. His other identification of lavas, in the Comet Formation just east of Confidence Saddle on the North-east Dundas Tram, was not verified by the writer. If it does occur, Blissett's more likely interpretation of the stratigraphy (fig. 4 vs. fig. 3) is that its horizon is the Brewery Junction Formation. Overall, the active vulcanism seems to be restricted to horizons in or near the Brewery Junction Formation. Banks (1956), summarizing the literature, reports the tuffs of Dundas Group sequences to vary in composition from spilitic to quartz keratophyric for the lithic tuffs, and ffom albite-augite tuffs to quartz-albite tuffs for the crystal tuffs. This is true even of pyroclastic and volcanic detrital material, the majority of which occurs in the Razorback Conglomerate, and in the coarse Fernfields Formation (Plate 5).

<u>Success Creek Group - Huskisson Group</u>

At Zeehan, the Success Creek Group contains spilites. The latter range up to the top of the Middle Cambrian at Smithton (Solomon, 1964).

The overlying Crimson Creek Formation is probably devoid of tuffs in the type section, as the writer has microscopically identified Taylors's "tuffs" in the Renison Bell - Rosebery area as greywackes, which often contain, nevertheless, a considerable proportion of detrital volcanic material, both spilitic and acid in composition, although the former predominates. Only one lava flow has been reported from the Formation, a vesicular basalt occurring just west of the mouth of the Huskisson River, about half way up the type section.

The Huskisson Group contains one obvious tuff in Formation 10.

> "....the groundmass....of dark grey, extremely fine material, with irregular feldspathic particles ranging up to $\frac{1}{8}$ in. in diameter distributed irregularly. No bedding appears....nor does there appear to be any laminated arrangement of particles". (Taylor, 1954, p. 30).

Taylor correlated this level with the Curtin Davis Volcanics horizon in the Dundas area.

Rosebery Area

The acid lavas and pyroclastics of the Mt. Read Volcanic arc - basally potash-rich, and sodium-rich above (Solomon, 1964) - outcrop at the eastern end of the area, although there is probably a fault junction. Nevertheless, interdigitation has somehow occurred across this junction, in the form of the Natone volcanics.

B: Intrusive Rocks

(i) Genetically associated with the basic volcanic suites in the Success Creek Group, the Crimson Creek Formation, and the Dundas Group, are small intrusions of saussuritized albite gabbro, of the same composition as the spilites (Solomon, 1964). Further sill-like bodies of serpentinite and partly serpentinized pyroxenite (e.g. the Exe River bronzitite - 32104) intrude at or near the Crimson Creek - Dundas Group boundary. Carey (1953) considered these to be Cambrian, with the possibility that some were Devonian. Banks (1956) lists the following indicators of their Cambrian age.

(a) They intrude Dundas Group rocks up to the Fernflow Formation.

(b) The Owen Conglomerate contains osmiridium, chromite and some gold.

(c) At Adamsfield, Upper Cambrian sediments contain boulders of serpentinite.

However, Banks also considers that Lower Devonian faulting does not displace the Wilson River serpentine, the implications of which notably extend the time-range of emplacement of these bodies.

(ii) In the Renison Bell area, quartz-porphyry dykes, associated with the sulphide-cassiterite mineralization, are confined to the anticlinal hinge. These represent part of the acid igneous activity of the Tabberabberan Orogeny, although Solomon (1964) considers that they probably post-date the granite stocks.

6 CONDITIONS OF DEPOSITION

The established picture of sedimentation in the period under discussion is as follows. Younger Proterozoic miogeosynclinal conditions were interrupted by the Penguin Orogeny (placed by various authors at slightly different levels), which was followed, after deposition of at least part of the Success Creek Group, and of the Carbine Group, by a marked change to eugeosynclinal conditions - the Dundas Trough - with accompanying basic volcanic activity. After the filling of the Cambrian basin, and the Jukesian Orogeny, Ordovician sedimentation proceeded in the fault trough between the Tyennan and Rocky Cape Geanticlines.

This general picture is not contradicted by the present study. The analysis of the Crimson Creek Formation, with its poor sorting and mineralogical immaturity, indicates a sudden deepening of the trough, with the sinking rate outstripping the rate of sedimentation, producing a change in the facies from that of the miogeosynclinal sandstone-siltstone, dolomitic, and calcareous suite.

The poor sorting, rapid changes of lithology, mixtures of fragment-types, and graded bedding all indicate possible deposition by turbidity currents.

The composition of the fragments indicates source-areas mainly outside the trough, as the rock fragment component is dominantly quartzite and spilite. The mineral fragment component has both acid and basic volcanic affinities, possibly implying derivation of sediment from the east and west - from the Mt. Read Volcanic arc (?), which may have existed at this time adjacent to the trough; and from spilitic component of the Success Creek Group, and possibly of the base of the Crimson Creek itself. As previously inferred, there are apparently no cycles of deposition.

Sedimentation in the Dundas Group has apparently been more complex. The sources of material probably were:

(a) fine material from the shores of the eugeosyncline (into the siltstones);

(b) coarse material such as quartzite fragments from the shores, possibly transported by turbidity currents;

(c) volcanic activity, producing submarine (?) lavas and tuffs;

(d) the erosion of volcanic assemblages, possibly of the Mt. Read Volcanics, and definitely of pre-Dundas(?) spilitic suites;

(e) the erosion of intra-eugeosynclinal, tectonically active ridges, giving rise to the lower-Dundas Group lithic component of many higher-Dundas Group greywackes. (Solomon, 1962).

Because of the complexity thus suggested by the fragment composition and textures of the Dundas Group lithologies, and also because of the general impersistence of horizons in the sequence, there may not be eight cycles of sedimentation as postulated by Banks (1957).

If they do exist - and the Hodge-Razorback - Brewery Junction - Fernfields boundaries are the only definite breaks in the succession - then they surely do not have a single genetic explanation.

It is not at all obvious to the writer that the major part of the sedimentation was due to turbidity current deposition. Graded bedding is not common, and most of the rock textures and compositions do not necessarily imply such a mode of deposition.

The same remarks probably apply to the Huskisson Group, although deposition there was of a generally finer grain-size than in the Dundas Group (which is twice as thick), conglomerates being subordinate to siltstone and greywacke. Banks' (1956) division of the sequence into 11 cycles of deposition, which are probably complicated by polygenetic fragment-composition, must also be modified in the light of Blissett's remapping (Table III), which advanced formations 15, 16, 17, and 19 into the overlying Mt. Zeehan (or Owen) Conglomerate. This would reduce the number of cycles to 9, which agrees more closely with the 8 postulated at Dundas.

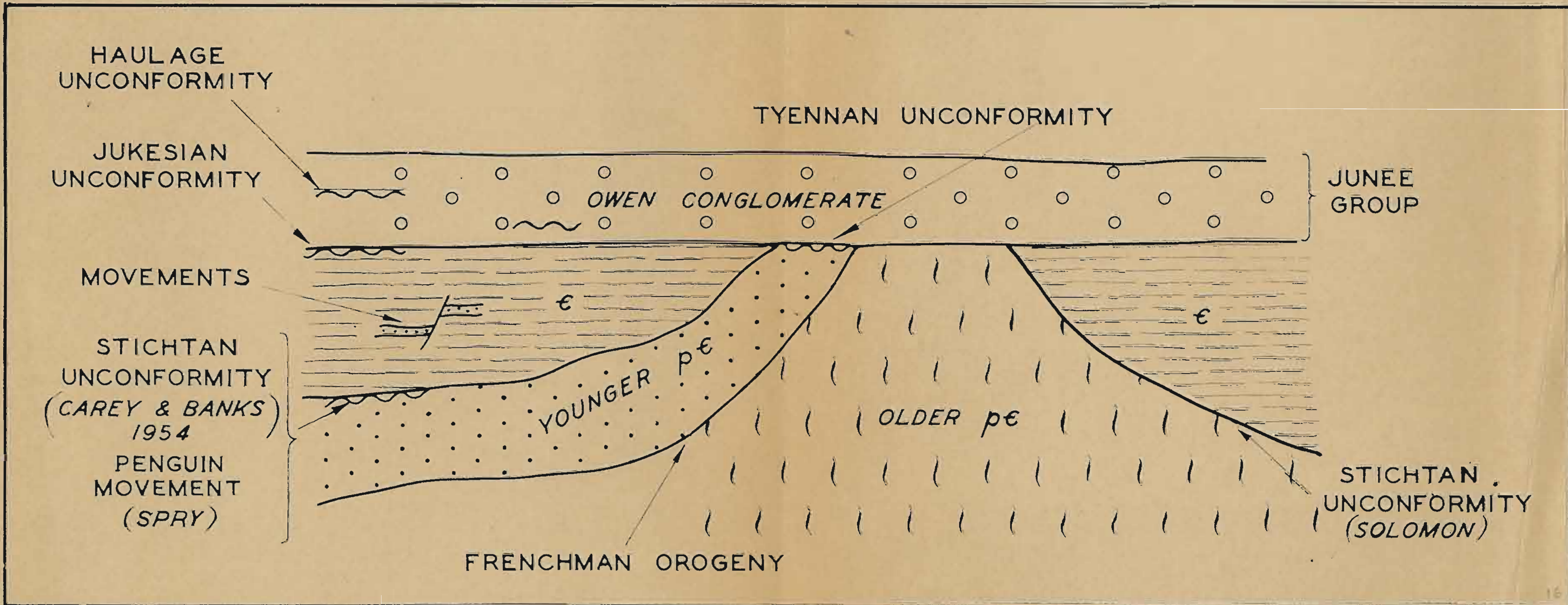
Summarizing the information, the main lithologies in the Cambrian trough sedimentation (15-20,000 feet) are paraconglomerates, greywackes, and siltstones, rapidly interbedding and strongly lenticular. In Middle and Upper Cambrian time, the trough began to sink more slowly and the water became more shallow, especially in the southern part of the area, with predominant conglomerates, compared with the northern part, with finer sediments. Concurrent with some part of all this activity, the (submarine?) Mt. Read Volcanic arc to the east was amassing a 10,000 foot pile of lavas and pyroclastics. At the close of the Cambrian, the Jukesian Orogeny caused the abrupt cessation of sedimentation in most places, although at the top of the Huskisson and Dundas Groups there may occur, according to Campana and King's (1963) interpretation, a continuous transition from the eugeosynclinal conditions through to a quiescent stage of "continental red-facies" sedimentation. That the Misery Conglomerate represents this transition, however, is questionable, as its fragment composition was found by the writer to vary little from that of many other conglomerates in lower horizons of the Dundas Group.

7 DEFORMATION AND METAMORPHISM

The nomenclature of the lower Palaeozoic unconformities is given in figure 16. Campana and King (1963) and Solomon (1964) have suggested that the Penguin Orogeny occurred before the deposition of at least part of the Success Creek Group - Carbine Group sedimentation, somewhere in the Upper Proterozoic. The writer's observations of comparitive deformation supports this interpretation in the Renison Bell area, but not in the Dundas area, where greater deformation of the Carbine Group has occurred, which seems to become more pronounced to the east towards the anticlinal high.

Whatever the position of this orogeny, the grade of regional metamorphism of post-orogenic rocks is not high, although it is ubiquitous in all Dundas Group correlates (Banks, 1956). The finer grained sediments, particularly in the Crimson Creek Formation, could be termed argillites, in that they are compact, massive, and indurated. However, the development of "slates", reported by so many workers, is a misleading interpretation, as only the first signs of metamorphic re-orientation were seen microscopically in some of the lithic fragments in the Crimson Creek Formation, and these cannot be proved not to have derived from pre-Penguin successions.

In the coarser horizons, induration has taken the form of chloritization in preference to silicification, and once again the grade of metamorphism in, e.g. the (Carbine Group correlate) Munro Creek Slate and Quartzite, is slightly higher than on the other side of the synclinorium. Horizon 6 in figure 12 is an example of local dynamic-metamorphic schisting.



After Solomon (1962)

FIGURE 16.

8 CORRELATIONS

It has been emphasised by many workers in this area that reliable correlations can be made only on a palaeontological basis, but general indications of contemporaneity (or otherwise) of deposition can be inferred from comparitive deformation and condition of deposition.

The correlation of the Dundas and Huskisson Groups has been confused by Banks (1956) and Blissett (1962), who referred to a correlation of the Hodge Slate and Huskisson Group formation 3 by Taylor (1954). Taylor made no such correlation, preferring to equate formation 3 with the lower Middle Cambrian Ptychagnostus gibbus fauna of the Judith Formation (Taylor, 1954, Addendum, p.3). This removes part of the difficulty discussed by Banks (1956, pp. 191-2) - namely that Opik (1961 b) correlated the Hodge Slate with formation 14, (and Taylor with formation 3).

The other part of the difficulty is that both correlations were based mainly on the occurrence of dendroids, which were presumed to be confined to the Hodge Slate. However, Blissett has confirmed the occurrence of dendroids both in formation 14, and below formation 3. He therefore considers Opik's correlation to be unlikely, as the dendroids must range from Middle to Upper Cambrian.

Reliable index-fossil correlation therefore stands as follows.

UPPER: Huskisson Group: Formation 18 (= 14 ?) : *Glyptagnostus reticulatus* : lower Franconian (Banks), lower Dresbachian (Blissett); in the Upper Cambrian.

Dundas Group: Bonnie Point mudstone (North-east Dundas Tram) : *Pseudagnostus*, etc.: lower Dresbachian (Banks).

Dundas Group: Comet Formation: *Blackwelderia*, etc. : upper Middle Cambrian.

Dundas Group: Hodge Formation : Dendroids, *Solenoparia*, Bathyuriscids : middle Middle Cambrian.

Dundas Group: Judith Formation (?) : *Ptychagnostus gibbus* : lower Middle Cambrian.

There is therefore no fauna common to both sequences.

Determination of the correlation and juxtaposition, of the major upper Proterozoic and Cambrian succession is outside the scope of this thesis. Nevertheless, the following points are relevant.

(a) Interdigitating of the Natone Volcanics (= Mt. Read Volcanics) and correlates of the Success Creek Group (= Carbine Group ?) suggests qualitatively that at least part of the Mt. Read Volcanics were deposited early in the Cambrian. However, there are too many unknowns in this correlation to make it more than a guess.

(b) The relationship between the Carbine Group (?) and the upper Mt. Read Volcanics was examined at Williamsford. The Carbine Group is folded along north south axes, which do not show appreciable plunges. Blissett mapped Crimson Creek Formation to the east of the anticlinal high (?), but this identification, and the field relations generally, are uncertain. The writer noted west-dipping micaceous sandstones and shales in the township itself, which disagrees with extrapolation from figure 4. The contact with these sediments and the volcanics is, however, obscured, at least as far south as the Hercules haulage, and as far north as was mapped by the writer, that is, the Stitt River. It is probably a faulted junction.

9 STRUCTURE

Regional

The major structures in the area are the SE - plunging Renison Bell anticline, the NW - plunging Huskisson Syncline, and the N-S Dundas anticlinal zone. The first and last of these structures forms a Y, the apex of which is occupied by the plunging syncline.

The structural history has been variously interpreted. Campana and King (1963) invoke a Cambrian (N-S?) and a Devonian (Tabberabberan, NW) combination of orogenies, the former also being responsible both for -

(i) a postulated unconformity above the Mt.Read Volcanics (on which the Dundas and Huskisson Groups, and the Crimson Creek Formation, were deposited), and

(ii) the Read-Rosebery mineralization.

Solomon (1964) finds no evidence for the implied Cambrian age of the NNW cleavage (which has controlled ore deposition). He discounts the evidence for a major Cambrian orogeny, and the writer has found no evidence for an unconformity between the Rosebery Series - coeval with at least part of the Mt. Read Volcanics - and the Crimson Creek Formation.

Solomon (1962, 1964) has postulated instead, a two-phase Tabberabberan deformation, with initial long-wavelength N-S folds, cross-cut by later, tighter, WNW to NNW folds. This produced the Dundas anticline, and the Huskisson and Renison Bell anticlines, respectively. The complicated resulting structural pattern is similar to that illustrated in de Sitter, fig 245 (Plate 22).

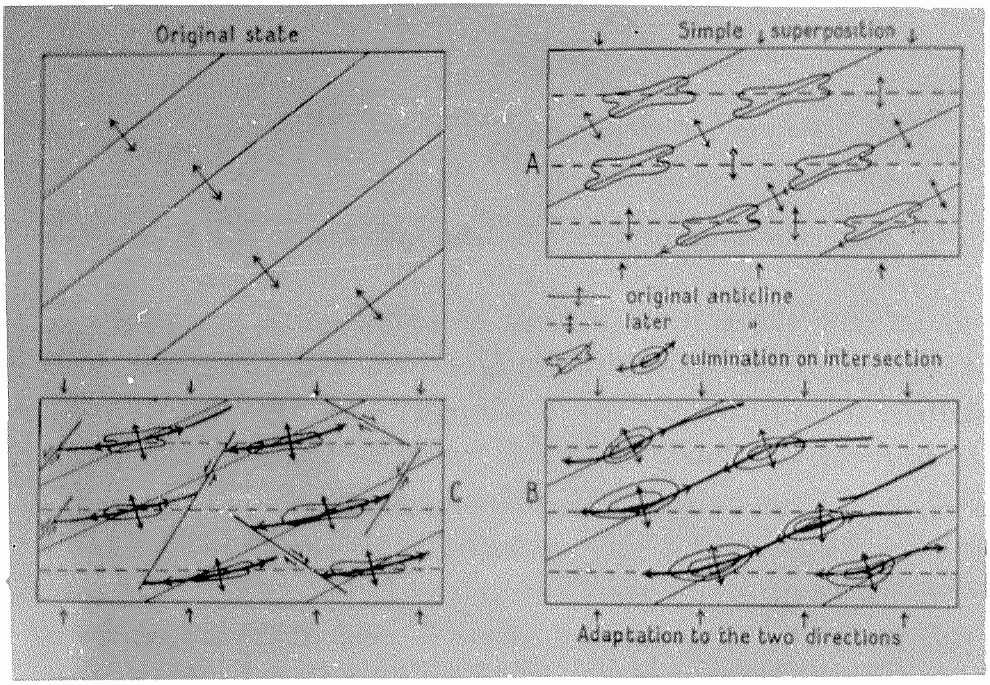


Plate 22.- Diagrams of interference of folding in successive directions. After De Sitter (1956), figure 245.

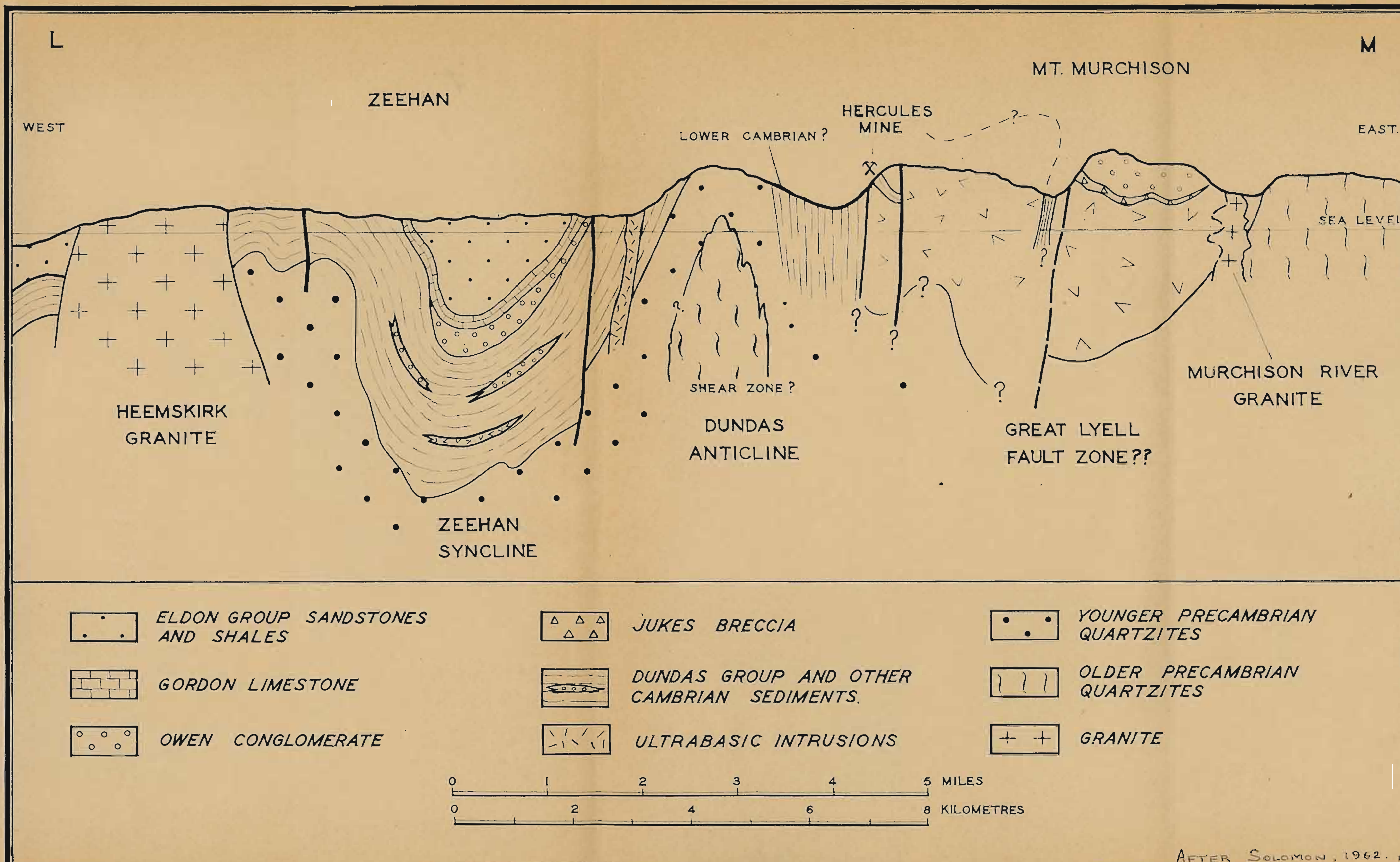

L
M
MT. MURCHISON
ZEEHAN
HERCULES
MINE
WEST
LOWER CAMBRIAN ?
EAST.
SEA LEVEL
SHEAR ZONE ?
HEEMSKIRK
GRANITE
DUNDAS
ANTICLINE
GREAT LYELL
FAULT ZONE??
MURCHISON RIVER
GRANITE
ZEEHAN
SYNCLINE
ELDON GROUP SANDSTONES AND SHALES
GORDON LIMESTONE
OWEN CONGLOMERATE
JUKES BRECCIA
DUNDAS GROUP AND OTHER CAMBRIAN SEDIMENTS.
ULTRABASIC INTRUSIONS
YOUNGER PRECAMBRIAN QUARTZITES
OLDER PRECAMBRIAN QUARTZITES
GRANITE
0 1 2 3 4 5 MILES
0 2 4 6 8 KILOMETRES
AFTER SOLOMON, 1962.

FIGURE 10.

A further general feature that requires explanation is the arcuate trends of some of the NW fold axes. These may imply a complex interrelation between dextral (?) regional rotational stresses, and the effect of the massive geanticlinal blocks, which acted both as margins to the depositional basins, and as more rigid blocks deflecting or refracting the trend of the impressed strain. However, the relative importance of these factors in the area under discussion is not at all obvious. That regional stress systems do not necessarily leave their imprint on areas of this size, is clear from a consideration of the lode directions of the one deposits of the district. Many of these have a tensional component which trends <u>parallel</u> to the (second stage ?) NW Tabberabberan fold axes, an impossible situation to represent on a regional stress analysis diagram, but which could be due simply to small scale longtitudinal cracking along the line of the flexing anticline.

<u>Local Structure</u>

The broad scale local structure consists of

(a) the Dundas anticlinal zone, faulted down both to the east and to the west (fig. 10);

(b) the Renison Bell anticline, the plunge of which is reflected in the arcuate trace of the serpentinite at the junction of the Crimson Creek and Dundas rocks;

(c) the Dundas type-section homocline, which is the result of simultaneous (?) folding and sinistral tear-faulting, off the axis and onto the limb of the Renison Bell anticline, of part of the serpentinite - Dundas Group succession;

(d) the complex(meridional ?) faulting and folding in a line due north of the Older Proterozoic inlier, extending through the folded synclinorium axis on the Pieman River to the east-west faults which must truncate the southern end of the Huskisson syncline;

(e) the southern end of the Huskisson syncline.

The detailed local structure must be pure interpretation in most cases, due to the paucity of outcrop. This is, unfortunately, especially true at the north-eastern corner of the area, in the sector of the Rosebery Group interpreted by Campana and King (1963) as being overturned. The following considerations have helped to determine the interpretation given in figure 17.

(i) There is a zone of very concentrated NNE trending faulting which has a dextral component to its predominant tension.

(ii) The west dipping Rosebery Series must be faulted away from the east-dipping volcanics to the east, as the quartzite horizons do not repeat.

(iii) The strike-ridge of Onslow Hill on the north side of the Pieman, in the big bend, is possibly the fuchsitic breccia-conglomerate;

(iv) The southern end of the Colebrook Hill serpentinite is apparently cut off sharply.

(v) The Jupiter fault of Campana and King (1963) is unnecessary to explain the offset in strike of the Rosebery and Hercules mines, as Solomon (pers. comm.) has shown that the effect of relief on the east dipping ore-horizon is sufficient explanation. Further, such a large fault would have to be relieved at its south-western end, and no geological map of the area, including that of the authors (fig. 13), suggests any relieving structures.

(vi) An attempt has been made to construct fault movements consistent with respect to a single stress field. The field interpreted from the resulting pattern could be due to pure east-west compression, but on the regional scale, is more likely the ultimate result of an east-west sinistral rotational shear.

10 MINERALIZATION

Table IV is an analysis of forty selected ore deposits in the area. The writer intended to supplement this with mineragraphic examination of the specimens collected, but seven polished sections from the South Comet - Kosminski lode made it obvious that no meaningful results could be obtained without detailed sampling of in situ material, which is now impossible due to inaccessibility.

The seven sections did not reveal a definite paragenesis, mainly because the only criterion that could be used was caries texture, which is notoriously indeterminate with galena-sphalerite boundary relations. No evidence was found to contradict a normal sphalerite-galena sequence, but there was little positive indication. Siderite definitely follows both these minerals, and there is a late stage pyrite mineralization (which also suggests a complexity of paragenesis irresolvable from dump sampling).

The location and access of the mines described are plotted in figure 18, while part of the table has been summarized in figure 19.

The interpretations derived from this analysis are as follows.

(a) Considering the method of computation, the lead-silver ratios are relatively constant, implying a single source, and possibly a single phase, of mineralization.

(b) The observation by Solomon (1964) that lead-zinc-silver haloes ring sulphide-cassiterite ores is not well substantiated in this area. Although the writer would agree that the overall picture casts considerable doubt on the supposed zoning of the ores around the Heemskirk Granite as proposed by Ward (1911), the "halo" interpretation implies a rather rigid structural-stratigraphic control of mineralization associated with the cross folding (see plate 22), which is not apparent from the analysis.

(c) What is apparent is that the control of mineralization has been dominantly structural, and due to NNW faults, which in turn may be mainly longtitudinal tension cracks parallel to the second-stage(?) Tabberabberan fold axes (as they maintain their trend right across the N-S first-stage(?) Dundas anticline). This is not to deny the stratigraphic control of mineralization at Renison Bell, which is, however, and unfortunately, unique.

(d) The serpentinite boundary-faults are obviously deep fractures, enabling ready penetration of porphyry and/or mineralizing solutions, and therefore higher temperature-type deposition.

(e) The Hercules-Rosebery ore-body trends are coincident with the other Devonian deposits, which fact constitutes part of the evidence for their dating.

(f) The relationship of the temperature-type spread to the quartz porphyry is indeterminate, although its trend parallel to the average lode direction, together with the NNW-trending lines of high temperature-type deposits, suggests the occurrence of dykes similar to that at Renison Bell at no great depth. If any haloes occur (on this scale), they do so around these NNW high temperature-type trends.

Solomon (1964) has suggested that the large scale picture is one of a NE trend reflecting some pre-Tabberabberan tensional fracture zone, and controlling mineral deposition in a later period. The two interpretations are not incompatible.

TABLE IV (10 pages)

DATA FROM FORTY SELECTED ORE DEPOSITS

Contents

	Page
Tin deposits	i
Colebrook mine	iii
Rosebery - Hercules mines	iii
North-east Dundas Tram deposits	iii
Moore's Pimple mine	vii
Dundas Pb-Ag-Zn deposits	vii
Melba Flats deposits (incl. Cuni)	ix
Crimson Creek deposits	x

Notes on construction

(1) The element-ratios have been calculated from data in Blissett (1962) of total productions of mines. These data are of varying reliability, as some tonnages were only estimated. If these estimates were based on the average ratios for the area concerned, re-calculation of the ratios would be pointless. The writer considers, however, that there is sufficient diversity in the ratios to render this possibility unlikely.

(2) The deposits are analysed in terms of "Stage of paragenesis" in an attempt to discover any zoning effects across the area.

The basis for this analysis is part of the generalized paragenetic sequence for hydrothermal deposits of Edwards (1954, p. 136). This sequence places the ore and gangue minerals separately in their approximate order of deposition, the earliest minerals to form being cited first. The writer has added a tentative assessment of the grade of deposition temperature, as interpreted from Edwards' mineral assemblages.

Writer's temperature assessment	Edwards' classification: Ore	Edwards' classification: Gangue
High	1. (Not applicable)	
	2. cassiterite wolfram molybdenite	 quartz
Medium-high	3. pyrrhotite Ni sulphides arsenopyrite pyrite	tourmaline ———————*
Medium	4. {chalcopyrite {sphalerite	
Low-medium	5. tetrahedrite galena lead	 siderite
Low	sulphosalts silver sulphosalts bismuthinite stibnite	(with Mn?) fluorite calcite barite

(*: This division, which Edwards did not attempt to make himself, is estimated here on the basis of the zonal classification of Emmons (1924)).

Where the minerals of a deposit range over a number of these division, they are described as, e.g. "High - med., Ed. 2 - 4".

(3) The data on "Type of deposit", "Country rock", and "Line of lode", are compiled, unless otherwise indicated, from Blissett (1962) or Hall and Solomon (1962).

(4) Unbracketed "Igneous rock association" descriptions represent observed juxtapositions. Bracketed descriptions are interpretations, by the writer unless otherwise stated.

(5) Nineteen of the tabled mines were visited by the writer, but at only fourteen were useful samples found. These, together with mineral data collated by Blissett (1962), form the basis of the "Main minerals" list.

(6) Data from the mineragraphic examination of a number of the samples have not contributed significantly to the table.

TABLE IV (i)

	RENISON BELL (incl. Pine Hill)	EXE GORGE & FALLS; FENTONS	EXE PROPRIETARY
MAIN ELEMENTS (& RATIOS)	Sn, Pb, Zn, As, Bi, Cu, Sb, Ag, Fe, Mn, Ca, B, Mg	Sn, As, Fe.	Sn, Ca, B, Mg.
MAIN MINERALS	cassiterite pyrrhotite quartz tourmaline arsenopyrite chalcopyrite tetrahedrite carbonates	pyrite cassiterite arsenopyrite	cassiterite quartz tourmaline
STAGE OF PARAGENESIS	High - low-med. Ed. 2 - 5	High - medium. Ed. 2 - 3	High. Ed. 2
IGNEOUS ROCK ASSOCIATION	Adjacent to dyke	(Devonian acid igneous)	(Devonian acid igneous)
FISSURE OR REPLACEMENT	Replacement	Fissure	Complex fissure
COUNTRY ROCK	Upper Success Creek Group.	Crimson Creek Formation. Fault zone?	Crimson Creek Formation. Fault zone?
LINE OF LODE	Sills, and NE, NW faults	NNW	Irregular zone: NNW - NW
FIELD EXAMINATION	Brief surface reconn., 1963. Underground, 1958.	FENTONS: one adit. sampled. GORGE & FALLS: Dump examined.	Sampled mined ore, and glory hole.

OLYMPIC	ATHENIC	RAZORBACK	GRAND PRIZE
Sn (surface only) As, Fe.	Sn (surface only) As, Fe.	Sn, Pb, Cu, As, Bi, Sb, Ag, Mn, Fe, Ca, Mg.	Sn, Pb, Ag, Cu, As, Bi, Sb, Mn, Fe, Ca, Mg.
cassiterite arsenopyrite	cassiterite arsenopyrite pyrite	cassiterite pyrrhotite pyrite arsenopyrite chalcopyrite galena quartz carbonates	cassiterite pyrrhotite pyrite arsenopyrite chalcopyrite galena quartz carbonate
High - high-med. Ed. 2 - 3	High - high-med. Ed. 2 - 3	High - low-med. Ed. 2 - 5	High - low-med. Ed. 2 - 5.
(Devonian acid igneous)	(Devonian acid igneous)	(Devonian acid igneous)	(Devonian acid igneous)
Fissure?	Fissure?	Fissure (and replacement)	Fissure.
Upper "Rosebery Gp." or C.C.F. Near contact with serpentinite.	Upper "Rosebery Gp." or C.C.F. Near contact with serpentinite	Fault contact of Hodge Form. & serpentinite.	Brewery Junction Formation. Tear fault.
NNW, dip 55°E	NW	NNW	NNW
Sampled the three accessible adits.	Examined one adit. Rest of workings not found.	Examined present workings.	Examined glory hole and open cut.

COLEBROOK	ROSEBERY-HERCULES	ROSEBERY	MELBA
Cu, As, Fe, Ca,Mg. B, Pb, Sb, Ag, Zn.	Pb, Zn, Cu	Sn, Ca, Mg, B, F. W.	Pb, Zn, Sb, Ag. Pb:Ag = 275:1
IN ORDER OF DEPOSITION (FINUCANE, 1932) axinite actinolite Cu etc. sulphides calcite quartz	chalcopyrite sphalerite galena pyrite sulpharsenides sulphantimonides tetrahedrite gold	cassiterite tourmaline fluorite wolfram	galena jamesonite sphalerite stibnite pyrite epidote ? Cr mica (X-ray)
Med.-high - low-med Ed. 3 - 5	Medium - low Ed. 3 - 5	High Ed. 2	Medium - low. Ed. 3 - 5
(Devonian acid igneous)	Exhalative volc.? Dev. (Sol.& Hall) Camb. (C.&.K.'63)*	Exhalative volc.? Devonian (Sol. & Hall; C.&K. '63)	(Devonian acid igneous)
Metasomatic fissure replacement (Bliss.)	Replacement	Fissure	Fissure
Upper "Rosebery Gp" or C.C.F. Near contact with serpentinite	Mount Read Volcanics (Cambrian)	Mount Read Volcanics (Cambrian)	Serpentinite
N - S	N - S	?	NW
Extensive sampling from open cuts and Col. smelter (?) - Fig.	Underground examination and sampling, 1958	Scattered observations of fluorite, tourmaline, in fissures.	Sampled main dump

* Campana and King, 1963.

KAPI	HECLA	CARBINE	RAMSDALE
Pb, Ag, Zn, Fe, Ni (tr.) Pb:Ag = 162:1	Bi, Cu, Ag, Fe, As, Pb. Cu:Bi:Ag=41:40:1	Pb, Ag, Sb, Cu, An, As, Bi, Fe Pb:Ag = 312:1	Pb, Cu, Ag, Sb. Cu:Ag = 23:1
galena sphalerite sidertie dolomite? pyrite pyrrhotite NiS?	bismuthinite chalcopyrite pyrite pyrrhotite arsenopyrite siderite	galena sphalerite pyrite jamesonite tetrahedrite chalcopyrite arsenopyrite	pyrite tetrahedrite galena chalcopyrite
Med.-high - low-med. Ed. 3 - 5	Med.-high - low Ed. 3 - 5	Med. - high - low Ed. 3 - 5	Medium - low - medium Ed. 3 - 5
(Devonian acid igneous)	(Devonian acid igneous).	(Devonian acid igneous).	(Devonian acid igneous).
Fissure	Fissure	Fissure	Fissure
Fault contact of Hodge Formation and serpentinite	Dundas Group.	Dundas Group or Crimson Creek Formation	Dundas Group or Crimson Creek Formation.
N-S	NW-NNW dip 80^{o}W	N300^{o}	NNE
Dumps in Kapi Creek below waterfall sampled extensively.	Noté seen	Mine Not seen : ore sampled from loading point on Wallace's Train	Not seen

EVENDEN	HIGGINS	FRAZER	SOUTH-WEST CURTIN DAVIS
Pb, Zn, Fe.	Pb, Sb, Cu, Fe	Sn, As, Cu, Fe. As:Cu = 7:1	Sb, Bi, Cu, Ag
galena sphalerite pyrite	jamesonite chalcopyrite pyrite	cassiterite arsenopyrite chalcopyrite (pyrrhotite (lower) (marcasite (upper) pyrite	te~~t~~trahedrite bismuthinite siderite
Med. - low-med. Ed. 3 - 5	Medium - low Ed. 3 - 5	High - Medium Ed. 2 - 4 Marcasite 450°C.	Low-medium - low Ed. 5
(Devonian acid igneous).	(Devonian acid igneous).	(Devonian acid igneous).	(Devonian acid igneous).
Fissure	Fissure	Fissure	Fissure
Carbine Group	Carbine Group	Dundas Group	Dundas Group
?	?	NNW, dip steep E	NNE dip steep E
Not seen	Dump sampled. Poor specimens.	Not seen	Not seen

SOUTH CURTIN DAVIS	CURTIN DAVIS	NO. 1 CURTIN DAVIS	BONNIE DUNDEE
Cu, Sb, Pb, Ag.	Cu, Sb, Bi, Pb, Zn, Ag, Fe *	Pb, Cu, Sb, Ag, As, Bi, Fe.	Cu, Sb, Ag.
tetrahedrite galena native silver	tetrahedrite pyrite bismuthinite galena sphalerite siderite	tetrahedrite jamesonite galena pyrite arsenopyrite chalcopyrite bismuthinite siderite	tetrahedrite native silver
Low-medium Ed. 5	Medium - low-medium Ed. 4 - 5	Medium - low Ed. 4 - 5	Low - medium
(Devonian acid igneous).	(Devonian acid igneous).	(Devonian acid igneous).	(Devonian acid igneous).
Fissure	Fissure	Fissure	Fissure
Dundas Group	Dundas Group	Dundas Group	Dundas Group
NNW	NNW	NNW	NNE-NE
Not seen.	Dumps sampled for 1200 feet up Godkin Ridge	Not seen	Adit examined. No ore seen.

*For the four Curtin Davis mines: Cu:Pb:Ag = 32:4:1

FAHL - RING VALLEY	SVENGALI	MOORE'S PIMPLE	NORTH COMET
Cu, Sb, Fe, Pb, Ag Cu:Ag = 15:1	Cu	Pb-Ag, Zn, Ni, Cu, (Cr).	NONE
jamesonite galena chalcopyrite pyrite tetrahedrite siderite	chalcopyrite siderite quartz	galena sphalerite pyrite chalcopyrite zaratite* (fuchsite** dolomite	NONE
Medium - Low Ed. 3 - 5	Medium Ed. 4	Medium - low-medium Ed. 4 - 5	———
(Devonian acid igneous)	(Devonian acid igneous)	(Devonian acid Igneous)	———
Fissure	Fissure	Fissure	———
Crimson Creek Formation?	Crimson Creek Formation?	C.C. F. or "Rosebery Group": dolomitic quartzite contact with serp.	Oonah Group. Elliston (1951) reports a 485 ft. drive, quite barren
NNW dip steep W	———	NNW	———
Two main dumps sampled	Not seen	Not seen	Searched for without success

* Reid (1925) ** Blissett (1962)

WEST COMET	PLATT	COMET-MAESTRIES	ADELAIDE
Pb, Ag, Fe, Mn Cr. Pb: Ag = 360:1	Pb, Zn, Sb, Cr.	Pb, Ag, Cu, Fe, Mn, Ca, Mg. Pb:Ag = 528:1	Pb, Ag, Zn, Fe, Sb. Pb:Ag = 360:1
galena siderite Fe-Mn gossan cerargyrite? crocoite	galena tetrahedrite crocoite	galena chalcopyrite cerussite siderite dolomite	galena sphalerite pyrite jamesonite Mn-siderite dolomite crocoite cerussite
Low-medium Ed. 5	Low-medium Ed. 5	Medium - low-medium. Ed. 4 - 5	Medium - low Ed. 3 - 5
(Devonian acid igneous)	(Devonian acid Igneous)	(Devonian acid igneous)	(Devonian acid igneous)
Fissure	Fissure	Fissure	Fissure
Intersection of NW fault and contact of Carbine Gp. & serpentinite	Contact of Crimson Creek Formation and Carbine Group	Carbine Group	Contact of Carbine Group and serpentinite
NNE	N-S?	NNW	$345^{\circ}/60^{\circ}E$
All open cuts and low level on No. 2 ore body	Not found	Comet dumps sampled.	Sampled dumps and main adit.

KOSMINSKI	SOUTH COMET	BANNER CROSS	CUNI
Pb, Ag, Zn, Fe, Cu. Pb:Ag = 750:1	Pb, Ag, Zn, Fe, Cu. Pb:Zn: Ag = 550:795:1	Pb, Ag, Zn.	Cu, Ni, Fe Cu:Ni = 26:51
galena sphalerite quartz siderite pyrite chalcopyrite	galena sphalerite jamesonite pyrite chalcopyrite sphalerite	galena sphalerite	pentlandite pyrrhotite chalcopyrite millerite violarite pyrite
Medium - low-medium Ed. 4 - 5	Medium - low-medium Ed. 4 - 5	Medium - low-medium Ed. 4 - 5	Medium-high - medium
(Devonian acid igneous).	(Devonian acid igneous).	(Devonian acid igneous).	Intramagmatic, Cambrian?
Fissure	Fissure	Fissure	Fissure and replacement
Crimson Creek Formation, near Serpentinite.	Dundas Group	Carbine Group	Serpentinite
325°/65°W	NNW	?	N-S
All dumps sampled.	All dumps sampled.	Not seen	Not seen

MCKIMMIE	LEAD BLOCKS	ARGENT TUNNEL	CRIMSON CREEK DISTRICT
Pb, Ag, Fe. Pb:Ag = 408:1	Pb, Ag, Zn. Fe. Pb:Ag = 426:1	Pb, Cr, P.	Pb, Ag, Cu, Zn, Sb, As, Fe. Pb:Ag = 110:1
galena siderite	galena sphalerite siderite quartz	galena quartz crocoite pyromorphite	galena pyrite chalcopyrite sphalerite stibnite arsenopyrite quartz siderite
Low-medium Ed. 5	Medium - low-medium Ed. 4 - 5	Low-medium	Medium-high - low. Ed. 3 - 5
(Devonian acid igneous).	(Devonian acid igneous)	(Devonian acid igneous)	(Devonian acid igneous)
Fissure?	Fissure?	Fissure	Fissure
Contact of Crimson Creek Formation and Serpentinite	Crimson Creek Formation	Contact of Crimson Creek Formation and serpentinite	Base of Crimson Creek Formation
N-S?	?	E-W	NW
Not seen	Not seen	Not seen	Not seen

11 GEOMORPHOLOGY

Physiographic features were only studied incidentally to the mapping, and mainly in the Renison Bell-Rosebery area.

Stratigraphic control of relief is uncommon in these rocks. Conglomerates are exceptions, and these form strike-ridges at Mt. Razorback, Misery Hill, and possibly along the total length of the fuchsitic breccia conglomerate (interpreted from air photos) - if the outcrop illustrated is Plate 23 is any indication.

The other problem examined in passing was that of the Pleistocene glaciation. Moraine occurs in the Natone Creek valley (Plate 24), and there is a classic terminal moraine (see fig. 20) at Williamsford. As can be seen on this figure, most of the glacial material is probably redistributed, first on the plain of the old Pieman Valley (Plate 25), and then, with rejuvenation and incision of the stream system, from the plain into the bed and terraces of the present river. Such is probably the origin of the large boulders of Owen Conglomerate and Mt. Read Volcanics illustrated in Plate 25. Some of the reworked glacials that remain on the high-level surface are being covered by scree and soils, so that the profile of erosion and deposition is rather complex (Plate 27).

There is one feature of the reworked glacial deposits difficult to account for, and that is the continued presence on many steep hill slopes of a thin veneer of glacial detritus (e.g. Plate 28). A possible explanation is that the hill slopes on which these deposits were first laid down were graded with respect to the old flood plain of the Pieman River, and that with rejuvenation, the main work of the tributaries is in downcutting. Sheet erosion would then be subordinate, and the retention of the detritus would be favoured by the development in the present warmer climate of more prolific soil and vegetation. This hypothesis is not confirmed by the action of Natone Creek and its relatively small tributaries, which, although they occupy an enlarged valley grossly out of proportion to the size of the watershed, thus lacking sufficient power to rapidly incise and come to grade, have largely stripped the southern flanks of Westcott Hill, and the eastern side of the Colebrook Range, of glacial material. This may be an exceptional case, however, as Natone Creek is undercutting the western rather than the eastern side of the valley, thus enhancing the rapid erosion of the interfluves of the steeply graded tributaries. The problem is unresolved.

The direction of movement of the ice was up the valley of Natone Creek, but its ultimate source is unknown. It was a valley glacier similar to those which carved the topography on and beyond Mt. Murchison (fig. 21), and its associated lakes were the sites of deposition of several series of varves (Plate 29). Tracing of the course of glaciation will probably be very difficult, because this true moraine has been isolated in the re-entrant of Natone Creek, while none of the deposits towards its source have escaped reworking - at least in the area examined.

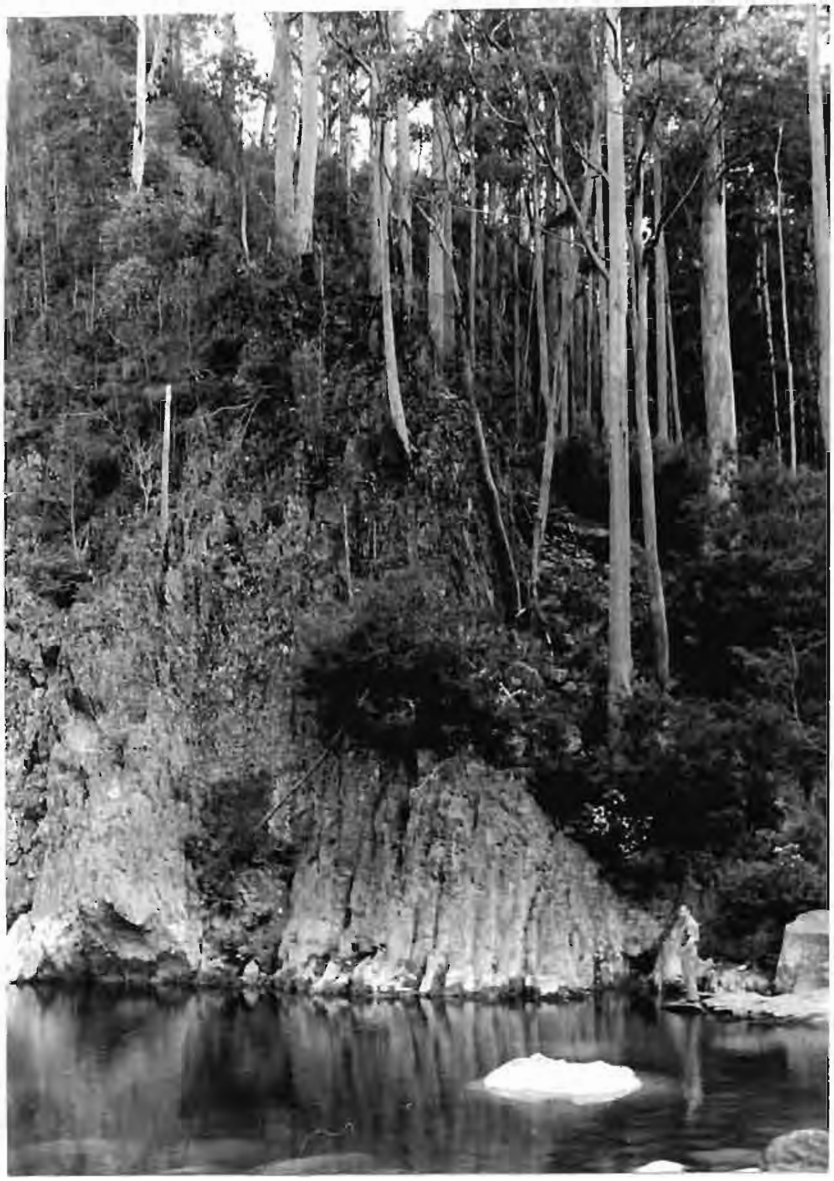


Plate 23.- Lithological control of relief. The 80 ft.-high strike ridge of the fuchsitic breccia-conglomerate on the Pieman River.

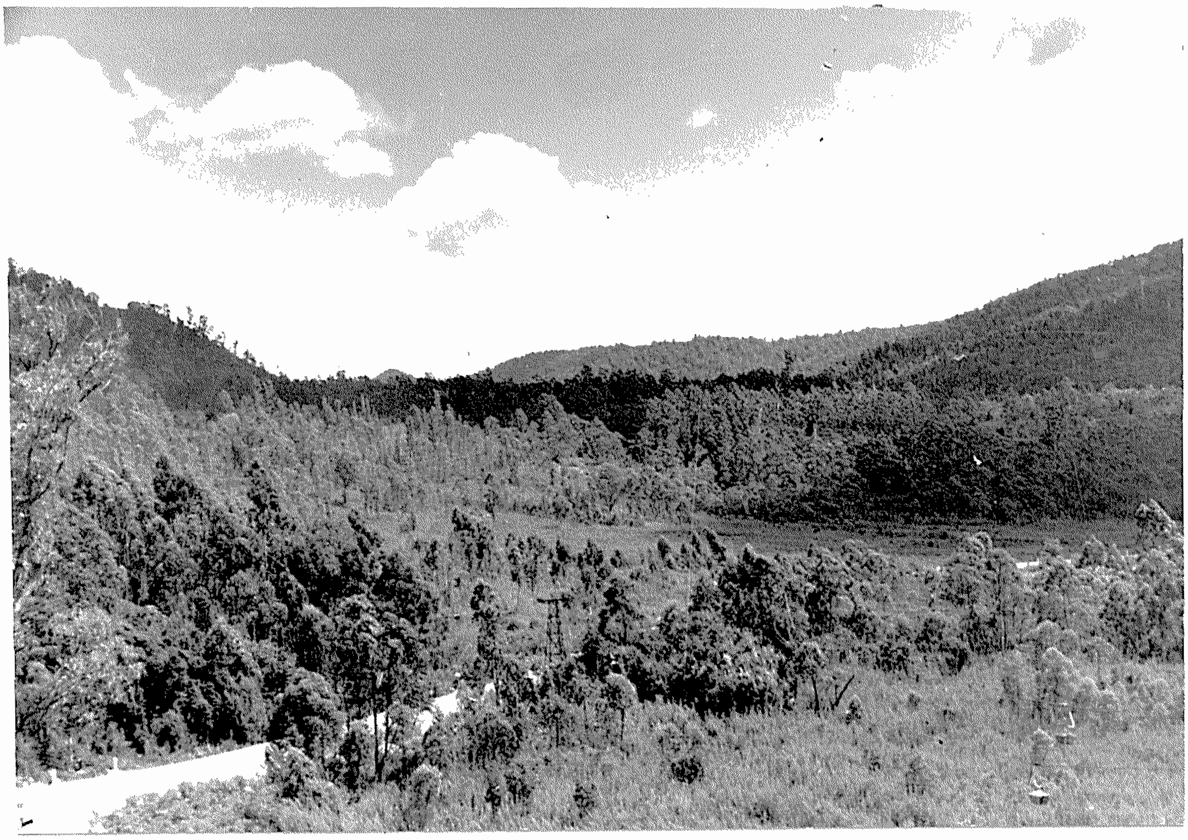


Plate 24.- The till-filled glacial valley of Natone Creek. Looking SSW.

Plate 25.- Reworked Pleistocene till. Railway cutting west of Rosebery station.

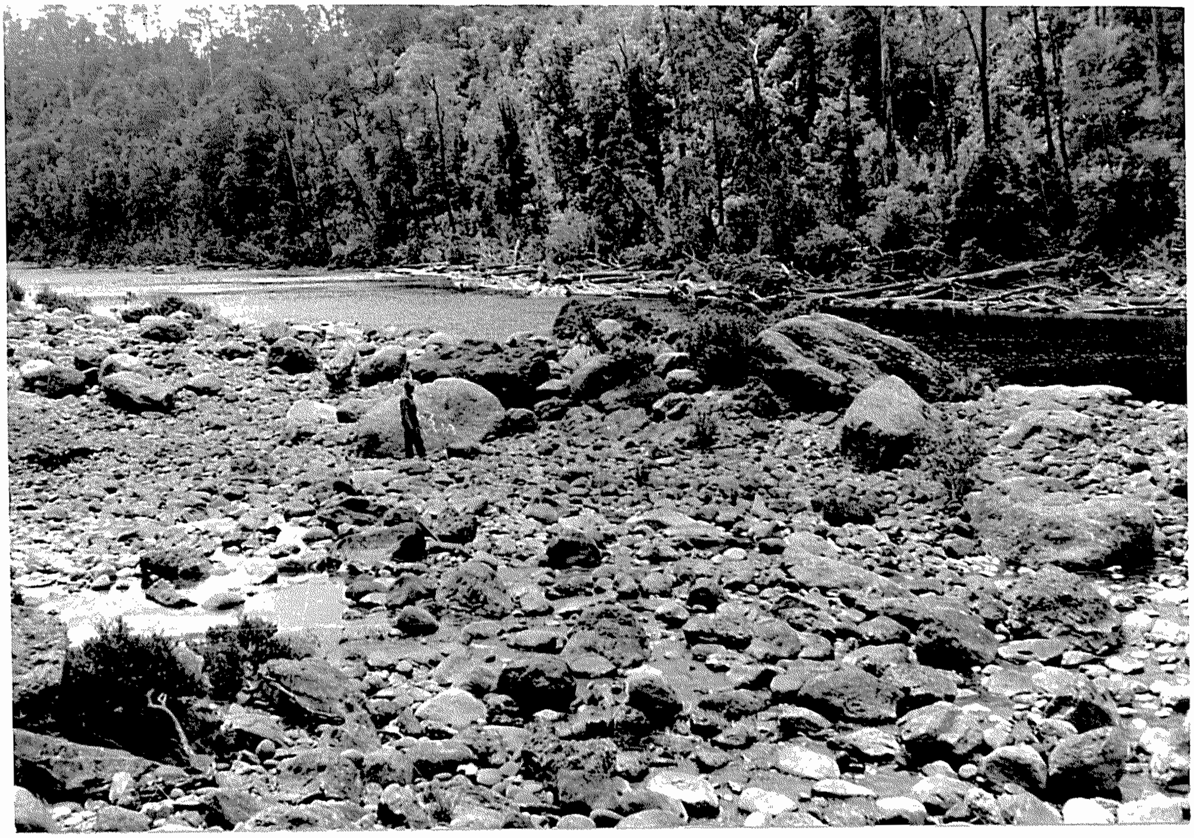


Plate 26.- The bed of the Pieman River (at low water level) at the mouth of Natone Creek. The largest boulders, and most smaller ones, are of Owen Conglomerate. Their deposition in this locality has been assisted by glacial transport.

Plate 27.- Recent Iron-rich detrital soil overlying stratified, reworked glacial deposits. At cutting in E.B.R. at N.W. corner of golf course.

Plate 28.- Redistributed till, overlying Munro Creek Slates and Quartzites (?), distorted at the top by hillside creep. Old Colebrook smelter.

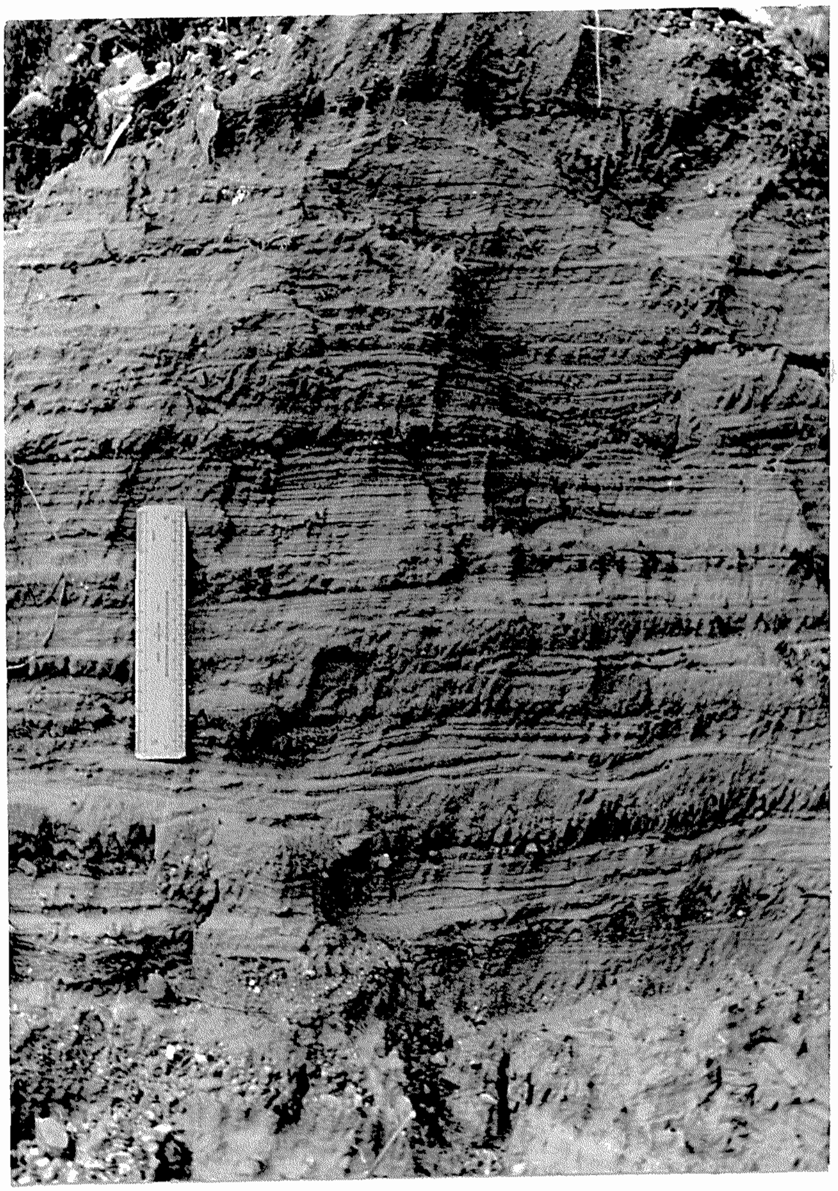
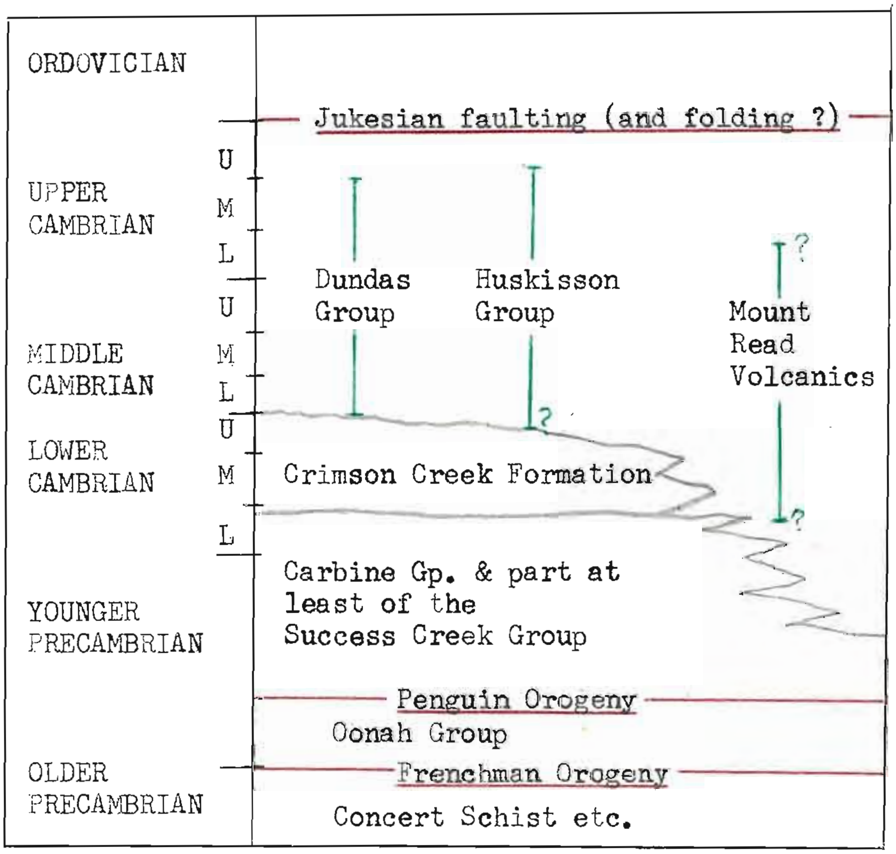


Plate 29.- Varves associated with the Natone Valley glaciation. Rule is six inches long. Road cutting 150 yds south of Rosebery cemetery.

12 GEOLOGICAL HISTORY

A tentative history of lower Palaeozoic events in the area may be generalized as follows.



13 APPENDICES

13.1 ROCK SPECIMEN INDEX & LOCALITY MAPS

This Index refers to a series of Specimen Locality Charts which are listed alphabetically, and are bound at the end of the index. The charts cover, in geographic sequence, traverses across the Dundas Group (D.G.), the Crimson Creek Formation (C.C.F.), and the succession in the Rosebery-Williamsford area. There is a Key Diagram showing the location of the larger scale charts.

The following illustrates the method used in listing the rocks.

EXAMPLE

31329* : B-26 : D.G., Climie (Ell.).

31329 is the catalogue number of the specimen in the Geology Department collection.

* means that a slide of the specimen is filed in the Geology Department slide collection.

B-26 is the locality number on the particular Specimen Locality Chart, each chart having its own series numbers.

D.G., Climie (Ell.) describes the geology at the specimen locality as interpreted by the author indicated in parenthesis, where

Bl. = Blissett, A.H., 1962

C.& K. = Campana, B. & King, D., 1963

Ell. = Elliston, J., 1954.

L-H = Loftus-Hills, G.D., 1964.

31300	B-1	gossan
31301*	B-2	Junee, Moina (Bl.)
31302*	B-3	Junee, Moina (Bl.)
31303	B-4	Junee, Moina (Bl.)
31304*	B-5	Pebble from D.G., Misery
31305*	B-6	Junee, Moina (Bl.)
31306*	B-7	D.G., Misery.
31307*	A-1	D.G., Misery.
31308*	A-2	D.G., Misery.
31309*	A-3	D.G., Climie.
31310	B-8	D.G., Climie.
31311*	A-4	D.G., Climie.
31312*	A-5	D.G., Climie.
31313*	B-9	D.G., Misery (Bl.) ?
31314*	B-10	D.G., Climie.
31315*	B-11	D.G., Misery (Bl.) ?
31316*	B-12	D.G., Climie.
31317*	B-13	D.G., Climie ?
31318*	B-14	Vein material.
31319	B-15	Vein material.

31320*	:	B-16	:	D.G., Climie ?
31321*	:	B-17	:	D.G., Climie ?
31322*	:	B-18	:	Misery (Ell.), D.G. (Bl.)
31323*	:	B-19	:	D.G., Misery (Bl.)
31324*	:	B-20	:	D.G., Climie ?
31325*	:	B-21	:	D.G., Conglomerate band, Misery ?
31326*	:	B-22	:	D.G., Climie ?
31327	:	B-23	:	D.G., Climie (Ell.)
31328	:	B-24	:	D.G., Climie (Ell.)
31329*	:	B-25	:	D.G., Climie (Ell.)
31330*	:	B-26	:	D.G., Climie (Ell.)
31331*	:	B-27	:	D.G., Fernflow (Ell.), D.G. (Bl.)
31332*	:	B-28	:	D.G., Fernflow (Ell.), D.G. (Bl.)
31333*	:	B-29	:	D.G., Fernflow (Ell.), D.G. (Bl.)
31334*	:	B-30	:	D.G., Fernflow.
31335*	:	B-31	:	D.G., Fernflow.
31336*	:	B-32	:	D.G., Fernflow.
31337*	:	B-33	:	D.G., Fernflow.
31338*	:	B-34	:	D.G., Fernflow.
31339*	:	B-35	:	D.G., Fernflow.
31340*	:	B-36	:	D.G., Fernflow.
31341	:	B-37	:	D.G., Fernflow.
31342*	:	B-38	:	D.G., Fernflow.
31343*	:	B-39	:	D.G., Fernflow.
31344*	:	B-40	:	D.G., Fernflow.

31345*	:	B-41	:	D.G., Fernflow (Ell.), Comet (Bl.).
31346*	:	B-42	:	D.G., Fernflow (Ell.), Comet (Bl.).
31347*	:	B-43	:	D.G., Fernflow (Ell.), Comet (Bl.)
31348*	:	B-44	:	D.G., Comet.
31349	:	B-45	:	D.G., Comet.
31350*	:	B-46	:	D.G., Comet.
31351	:	B-47	:	D.G., Fernfields.
31352*	:	B-48	:	D.G., Fernfields.
31353*	:	B-49	:	D.G., Fernfields.
31354*	:	B-50	:	D.G., Fernfields.
31355*	:	B-51	:	D.G., Fernfields.
31356*	:	B-52	:	D.G., Fernfields.
31357*	:	B-53	:	D.G., Fernfields.
31358*	:	B-54	:	D.G., Fernfields.
31359*	:	B-55	:	D.G., Brewery Junction.
31360*	:	B-56	:	D.G., Brewery Junction.
31361*	:	B-57	:	D.G., Brewery Junction.
31362*	:	B-58	:	D.G., Brewery Junction.
31363*	:	B-59	:	D.G., Brewery Junction.
31364*	:	B-60	:	D.G., Fernfields (Bl.) ?
31365*	:	B-61	:	D.G., Brewery Junction.
31366*	:	B-62	:	D.G., Brewery Junction.
31367*	:	B-63	:	D.G., Brewery Junction.
31368*	:	B-64	:	D.G., Brewery Junction.
31369*	:	B-65	:	D.G., Brewery Junction.

31370*	:	B-66	:	D.G., Brewery Junction
31371*	:	B-67	:	D.G., " "
31372	:	B-68	:	D.G., " "
31373*	:	B-69	:	D.G., " "
31374*	:	B-70	:	D.G., " "
31375*	:	B-71	:	D.G., " "
31376*	:	B-72	:	D.G., " "
31377*	:	B-73	:	D.G., " "
31378*	:	B-74	:	D.G., " "
31379*	:	B-75	:	D.G., " "
31380*	:	B-76	:	D.G., " "
31381*	:	B-77	:	D.G., " "
31382*	:	B-78	:	D.G., " "
31383*	:	B-79	:	D.G., " "
31384*	:	B-80	:	D.G., " "
31385*	:	B-81	:	D.G., Brewery Junction (Bl.), Razorback congl.(El
31386*	:	B-82	:	?
31387	:	B-83	:	Serpentinite gossan.
31388*	:	B-84	:	Serpentinite
31389	:	B-85	:	Serpentinite - Hodge Boundary
31390*	:	B-86	:	" " "
31391*	:	B-87	:	Serpentinite.
31392*	:	B-88	:	"
31393*	:	B-89	:	"

31394	:	B-90	:	D.G. Razorback conglomerate.
31395*	:	B-91	:	D.G., " "
31396*	:	B-92	:	D.G., " "
31397	:	B-93	:	D.G., " "
31398*	:	B-94	:	Fragment in " "
31399*	:	B-95	:	D.G., Hodge Slate.
31400*	:	B-96	:	D.G., Base of Brewery Junction.
31401*	:	B-97	:	D.G., " " "
31402*	:	B-98	:	D.G., " " "
31403*	:	B-99	:	D.G., Hodge (Bl.)
31404*	:	B-100	:	D.G., Hodge (Bl.), Razorback (Ell.)
31405*	:	B-101	:	D.G., " " "
31406*	:	B-102	:	D.G., " " "
31407	:	B-103	:	Serpentinite (Bl.)
31408	:	B-104	:	" "
31409*	:	B-105	:	" "
31410	:	B-106	:	" "
31411*	:	B-107	:	" "
31412	:	B-108	:	" "
31413*	:	B-109	:	" "
31414*	:	B-110	:	" "
31415*	:	B-111	:	" "
31416*	:	B-112	:	Carbine Gp. (Ell.)
31417*	:	B-113	:	"
31418*	:	B-114	:	Serpentinite (Bl.)
31419*	:	B-115	:	"

31420*	:	B-116	:	Carbine Gp. (Ell.)	
31421*	:	B-117	:	" " "	
31422	:	B-118	:	Concert Schist.	
31423	:	B-119	:	D.G., S. Comet Ridge Congl.	
31424	:	B-120	:	D.G., " " "	
31425	:	B-121	:	D.G., " " "	
31426	:	Key Diag:		Curtin Davis Volcs. ?	
31427	:	"	:	" " "	
31428	:	"	:	" " "	
31429	:	"	:	" " "	
31430	:	"	:	" " "	
31431	:	"	:	" " "	
31432	:	"	:	" " "	
31433	:	C-1	:	Primrose Pyrocl. (C. & K.).	
31434	:	C-2	:	" " "	
31435	:	C-3	:	" " "	
31436*	:	C-4	:	" " "	
31437	:	C-5	:	" " "	
31438*	:	C-6	:	" " "	
31439	:	C-7	:	" " "	
31440*	:	C-8	:	" " "	
31441	:	C-9	:	" " "	
31442*	:	C-10	:	" " "	
31443	:	C-11	:	" " "	(?)
31444*	:	C-12	:	" " "	

31445	:	C-13	:	Primrose Pyrocl. (C. & K.).
31446	:	C-14	:	Stitt Qtzite. (C. & K.) (current bed.)
31447	:	C-15	:	" " " "
31448	:	C-16	:	" " " "
31449**	:	C-17	:	Stitt Qtzite. (C. & K.)
31450	:	D-1	:	Mt. Read Volcs.
31451*	:	D-2	:	" "
31452	:	D-3	:	" "
31453	:	D-4	:	" "
31454	:	D-5	:	" "
31455	:	D-6	:	" "
32095	:	D-7	:	Mt. Read Volcs. ?
32096	:	D-8	:	" " ?
32097	:	D-9	:	?
32098	:	D-10	:	?
32099	:	D-11	:	?
32100	:	D-12	:	?
32101	:	D-13	:	?
32102	:	D-14	:	?
32103	:	D-15	:	?
31456	:	D-16	:	Munro Creek Slates & Qtzites (C. & K.). ?
31457	:	D-17	:	" " " " "
31458	:	D-18	:	" " " " "
31459	:	D-19	:	" " " " "

31460	:	D-20	:	Munro Creek,	Slates	& Qtzites	(C.&.K.) ?			
31461	:	D-21	:	"	"	"	"	"		
31462	:	D-22	:	"	"	"	"	"		
31463	:	D-23	:	"	"	"	"	"		
31464	:	D-24	:	"	"	"	"	"		
31465	:	D-25	:	"	"	"	"	"		
31466	:	D-26	:	"	"	"	"	"		
31467	:	D-27	:	"	"	"	"	"		
31468	:	D-28	:	"	"	"	"	"		
31469	:	C-18	:	Mt. Read Volcs.						
31470	:	C-19	:	"	"					
31471	:	C-20	:	"	"					
31472*	:	C-21	:	Stitt Quartzites (C. & K.)						
31473	:	C-22	:	"	"	"				
31474	:	C-23	:	"	"	"	?			
31475	:	C-24	:	"	"	"				
31476	:	C-25	:	Natone Volcs. (C. & K.)						
31477	:	C-26	:	"	"	"				
31478*	:	C-27	:	"	"	"				
31479	:	C-28	:	"	"	"				
31480	:	C-29	:	"	"	"				
31481	:	C-30	:	"	"	"				
31482	:	C-31	:	"	"	"				
31483*	:	C-32	:	"	"	"				
31484*	:	C-33	:	"	"	"				

31485*	:	C-34	:	Natone Volcs. (C. & K.)
31486*	:	C-35	:	" " "
31487*	:	C-36	:	" " "
31488*	:	C-37	:	" " "
31489*	:	C-38	:	" " "
31490*	:	C-39	:	Fuchsitic Breccia-congl. (C. & K.).
31491	:	C-40	:	" " " "
31492*	:	C-41	:	" " " "
31493*	:	C-42	:	" " " "
31494	:	C-43	:	" " " "
31495	:	C-44	:	Dolömite ? from costeän.
31496*	:	C-45	:	Sandstone: 30 ft. above Fuchsitic B/C.
31497	:	C-46	:	Granite from erratic (?) in gravel scrape.
31498	:	C-47	:	Siltstone: Westcott Dolomitic Beds (C. & K.).
31499	:	C-48	:	" " " " "
31500	:	C-49	:	" " " " "
31501	:	C-50	:	" " " " "
31502*	:	C-51	:	Munro Crk. Slates & Qtzites (C. & K.).
31503*	:	C-52	:	" " " "
31504*	:	C-53	:	" " " "
31505*	:	C-54	:	" " " "
31506*	:	C-55	:	" " " "
31507	:	C-56	:	" " " "
31508	:	C-57	:	" " " "
31509	:	C-58	:	" " " "

31510	:	C-59	:	Munro Ck.	Slates &	Qtzites	(C. & K.).
31511	:	C-60	:	"	"	"	"
31512	:	C-61	:	"	"	"	"
31513	:	C-62	:	"	"	"	"
31514	:	C-63	:	"	"	"	"
31515*	:	C-64	:	"	"	"	"
31516	:	C-65	:	"	"	"	"
31517*	:	C-66	:	"	"	"	"
31518	:	C-67	:	"	"	"	"
31519	:	C-68	:	"	"	"	"
31520	:	C-69	:	"	"	"	"
31521	:	E-1	:	C.C.F.	(L-H).		
31522	:	E-2	:	"	"		
31523	:	E-3	:	"	"		
31524	:	E-4	:	"	"		
31525	:	E-5	:	"	"		
31526	:	E-6	:	"	(Bl.)		
31527*	:	E-7	:	"	"		
31528*	:	E-8	:	"	"		
31529*	:	E-9	:	"	"		
31530	:	E-10	:	"	"		
31531	:	E-11	:	"	"		
31532	:	E-12	:	"	"		
31533	:	E-13	:	"	"		
31534	:	E-14	:	"	"		

31535	:	E-15	:	C.C.F., (Bl.)
31536	:	E-16	:	" "
31537	:	E-17	:	" "
32104*	:	E-18	:	Bronzite Gabbro.
31538	:	E-19	:	C.C.F., (Bl.).
31539	:	E-20	:	" "
31540	:	E-21	:	" "
31541	:	E-22	:	" "
31542	:	E-23	:	" "
31543	:	E-24	:	" "
31544	:	E-25	:	" "
31545	:	E-26	:	" "
31546	:	E-27	:	" "
31547	:	E-28	:	" "
31548	:	E-29	:	" "
31549	:	E-30	:	" "
31550*	:	E-31	:	" "
31551	:	E-32	:	" "
31552*	:	E-33	:	" "
31553	:	E-34	:	" "
31554	:	E-35	:	" "
31555	:	E-36	:	" "
31556*	:	E-37	:	" "
31557	:	E-38	:	" "
31558	:	E-39	:	" "

31559	:	E-40	:	C.C.F., (Bl.)
31560	:	E-41	:	" "
31561	:	E-42	:	" "
31562	:	E-43	:	" "
31563	:	E-44	:	" "
31564	:	E-45	:	" "
31565	:	E-46	:	Gabbro.
31566	:	E-47	:	C.C.F., (Bl.)
31567	:	E-48	:	" "
31568	:	E-49	:	" "
31569*	:	E-50	:	" "
31570	:	E-51	:	" " ?
31571*	:	E-52	:	" " ?
31572*	:	E-53	:	Altered Dolerite.
31573	:	E-54	:	" " ?
31574	:	E-55	:	" " ?
31575	:	E-56	:	C.C.F., (Bl.)
31576	:	E-57	:	" "
31577	:	E-58	:	" "
31578	:	E-59	:	" "
31579*	:	E-60	:	" "
31580	:	E-61	:	" "
31581	:	E-62	:	" "
31582	:	E-63	:	" "
31583	:	F-1	:	Pleistocene varves.

31584*	:	F-2	:	C.C.F., (Bl.).
31585	:	F-3	:	" "
31586*	:	F-4	:	" "
31587	:	F-5	:	" "
31588	:	F-6	:	" "
31589	:	F-7	:	" "
31590	:	F-8	:	" "
31591	:	F-9	:	" "
31592*	:	F-10	:	" "
31593*	:	F-11	:	" "
31594	:	F-12	:	" "
31595*	:	F-13	:	" "
31596*	:	F-14	:	" "
31597	:	F-15	:	" "
31598	:	F-16	:	" "
31599*	:	F-17	:	" "
31600	:	F-18	:	" "
31601*	:	F-19	:	" "
31602	:	F-20	:	" "
31603*	:	F-21	:	" "
31604*	:	F-22	:	" "
31605	:	F-23	:	" "
31606	:	F-24	:	Altered gabbro.
31607	:	F-25	:	C.C.F., (Bl.).

31608*	:	F-26	:	C.C.F.,	(Bl.).
31609	:	F-27	:	"	"
31610	:	F-28	:	"	"
31611*	:	F-29	:	"	"
31612	:	F-30	:	"	"
31613*	:	F-31	:	"	"
31614	:	F-32	:	"	"
31615*	:	F-33	:	"	"
31616	:	F-34	:	"	"
31617	:	F-35	:	"	"
31618	:	F-36	:	"	"
31619	:	F-37	:	"	"
31620	:	F-38	:	"	"
31621	:	F-39	:	"	"
31622	:	F-40	:	"	"
31623*	:	F-41	:	"	"
31624*	:	F-42	:	"	"
31625	:	F-43	:	"	"
31626	:	F-44	:	"	"
31627	:	F-45	:	"	"
31628	:	F-46	:	Success Creek Group Sandstone.	

32095-32103 are listed after 31455

32104 is listed after 31537.

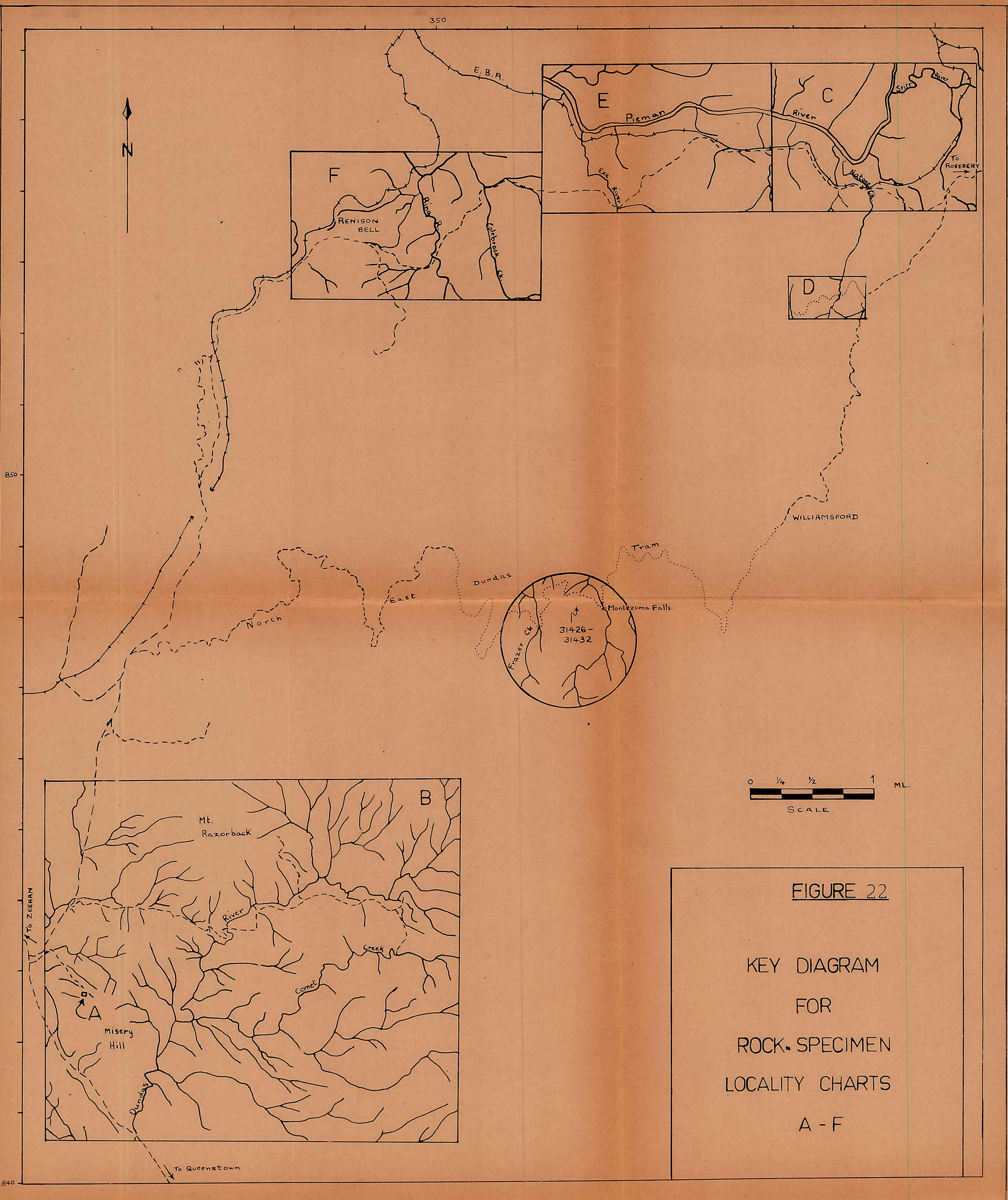
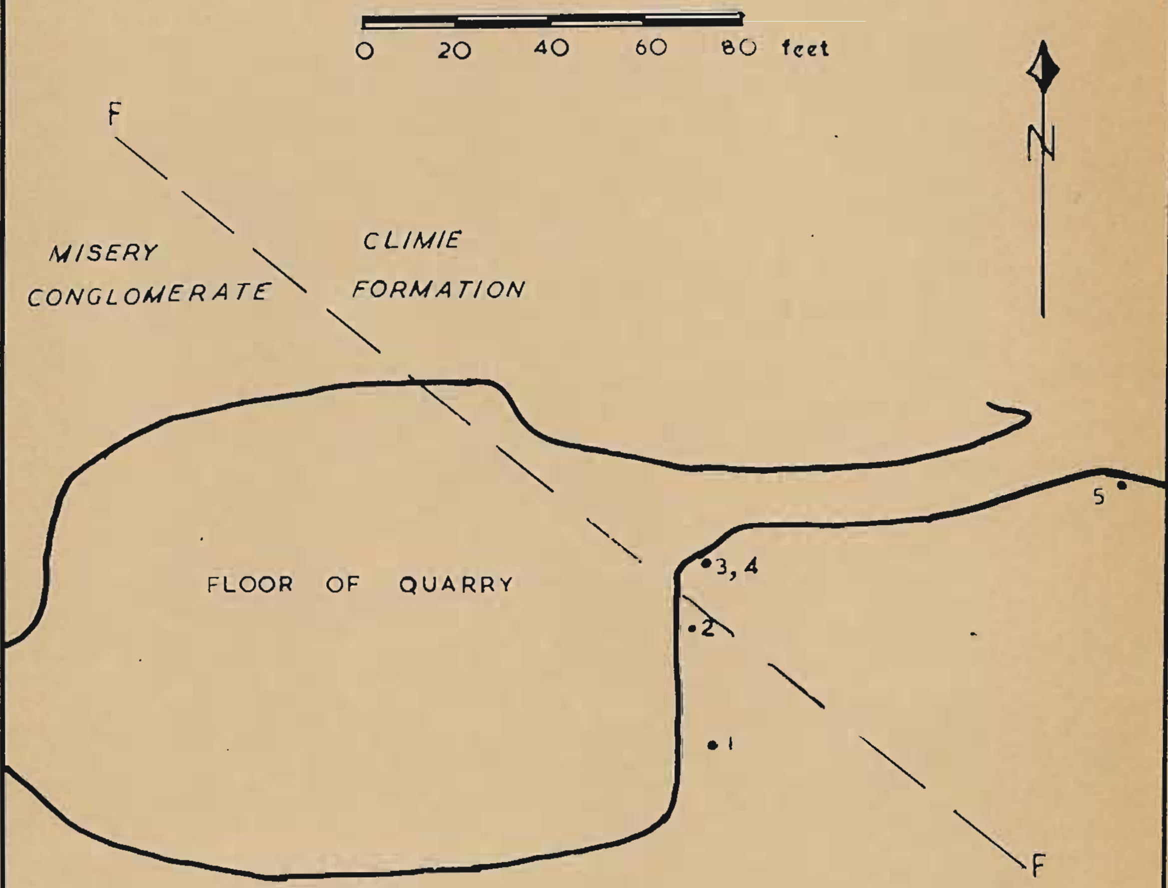


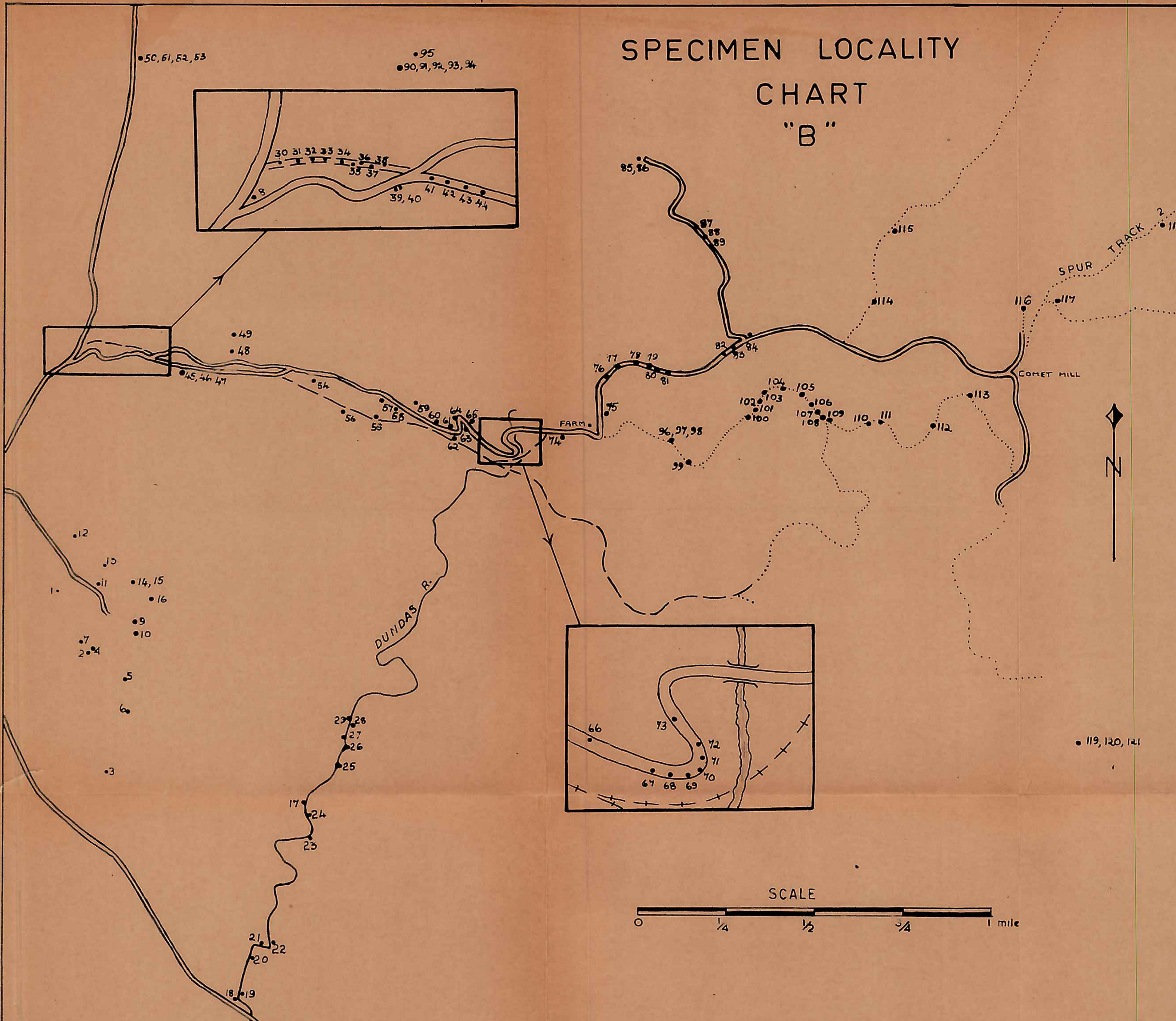
FIGURE 22

KEY DIAGRAM FOR ROCK SPECIMEN LOCALITY CHARTS A - F

SPECIMEN LOCALITY CHART "A"

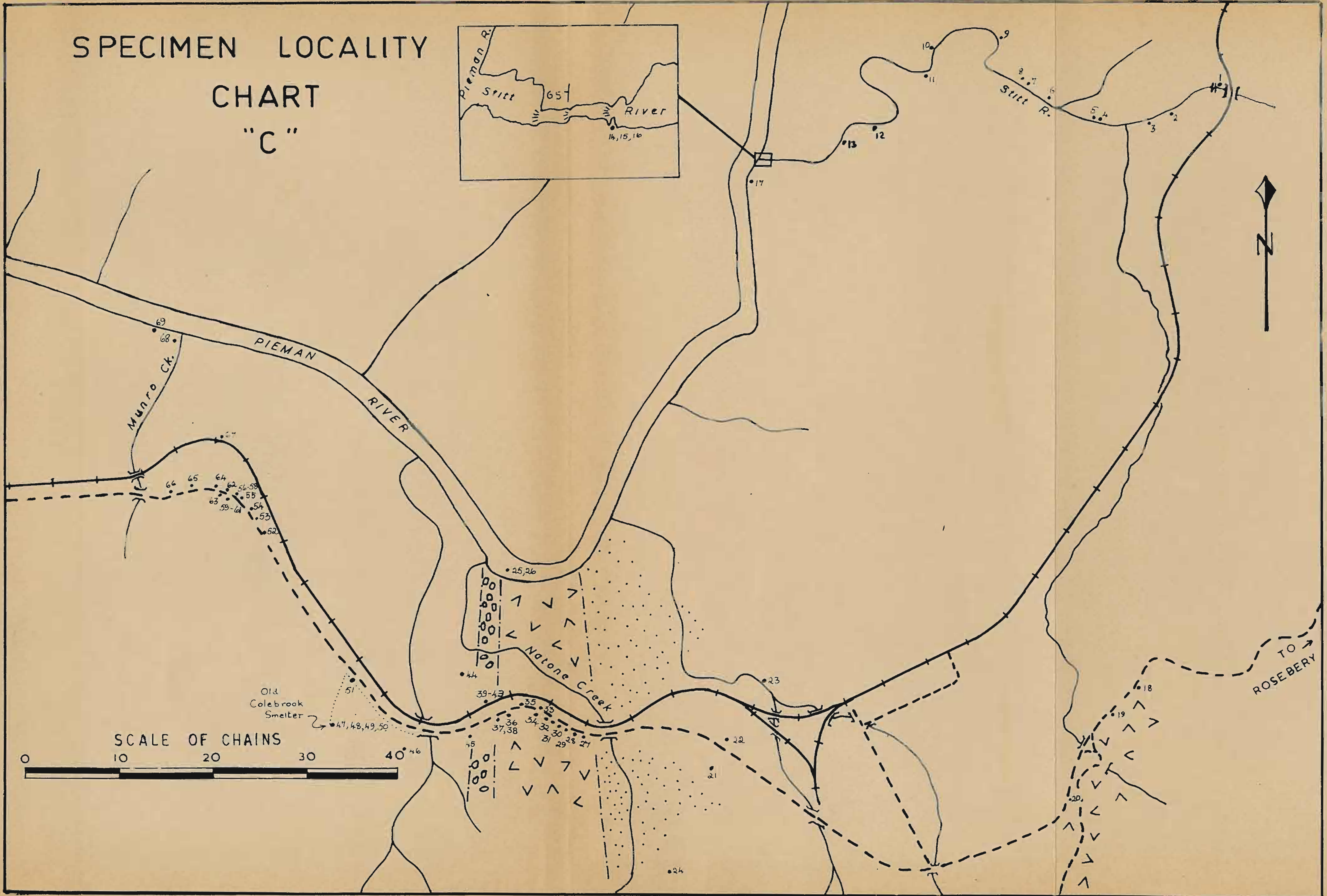


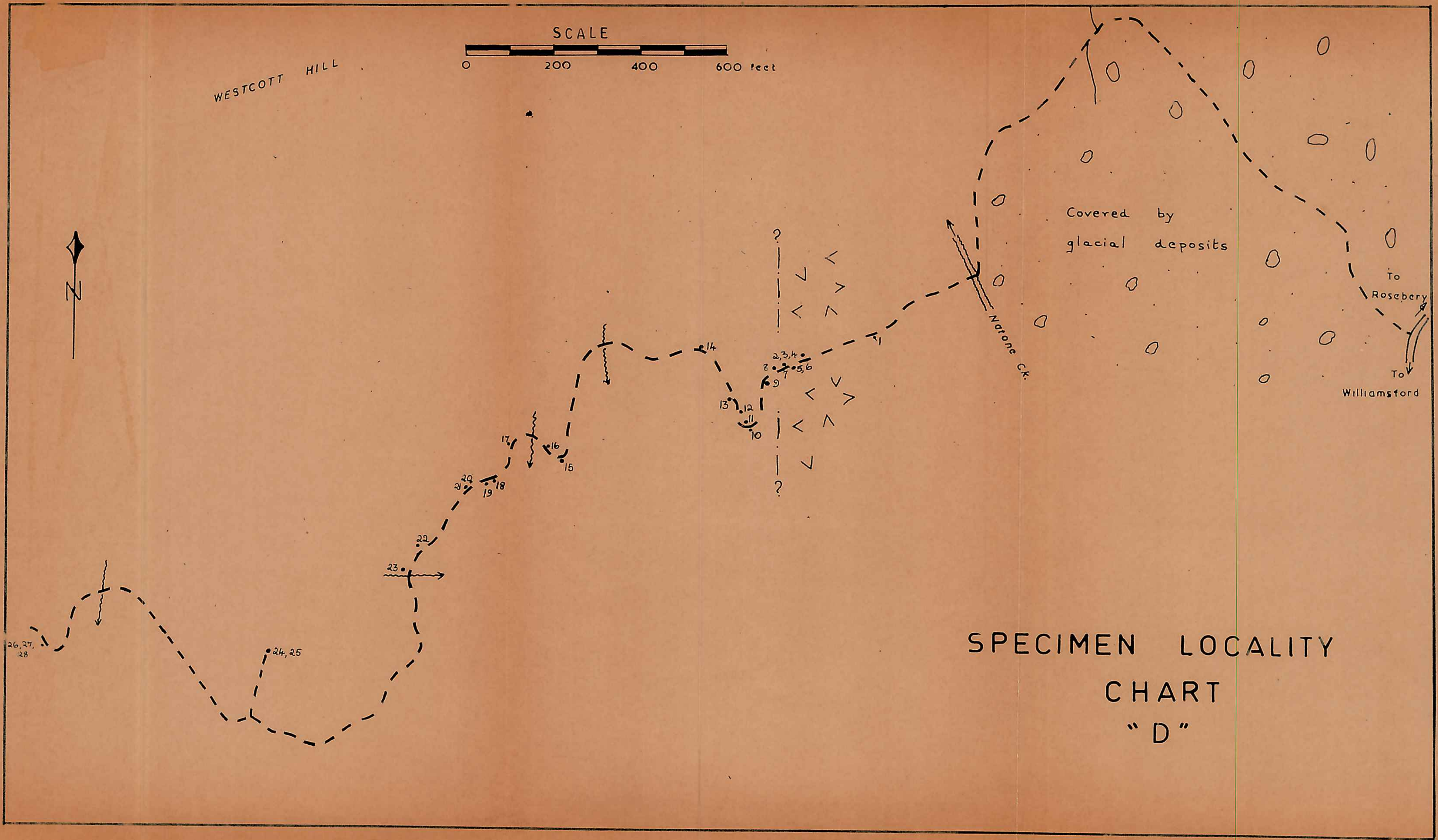
PLAN OF QUARRY — MISERY HILL , 16/3/63.



SPECIMEN LOCALITY CHART "B"
SPUR TRACK 2
COMET MILL
FARM
DUNDAS R.
SCALE
0
1/4
1/2
3/4
1 mile

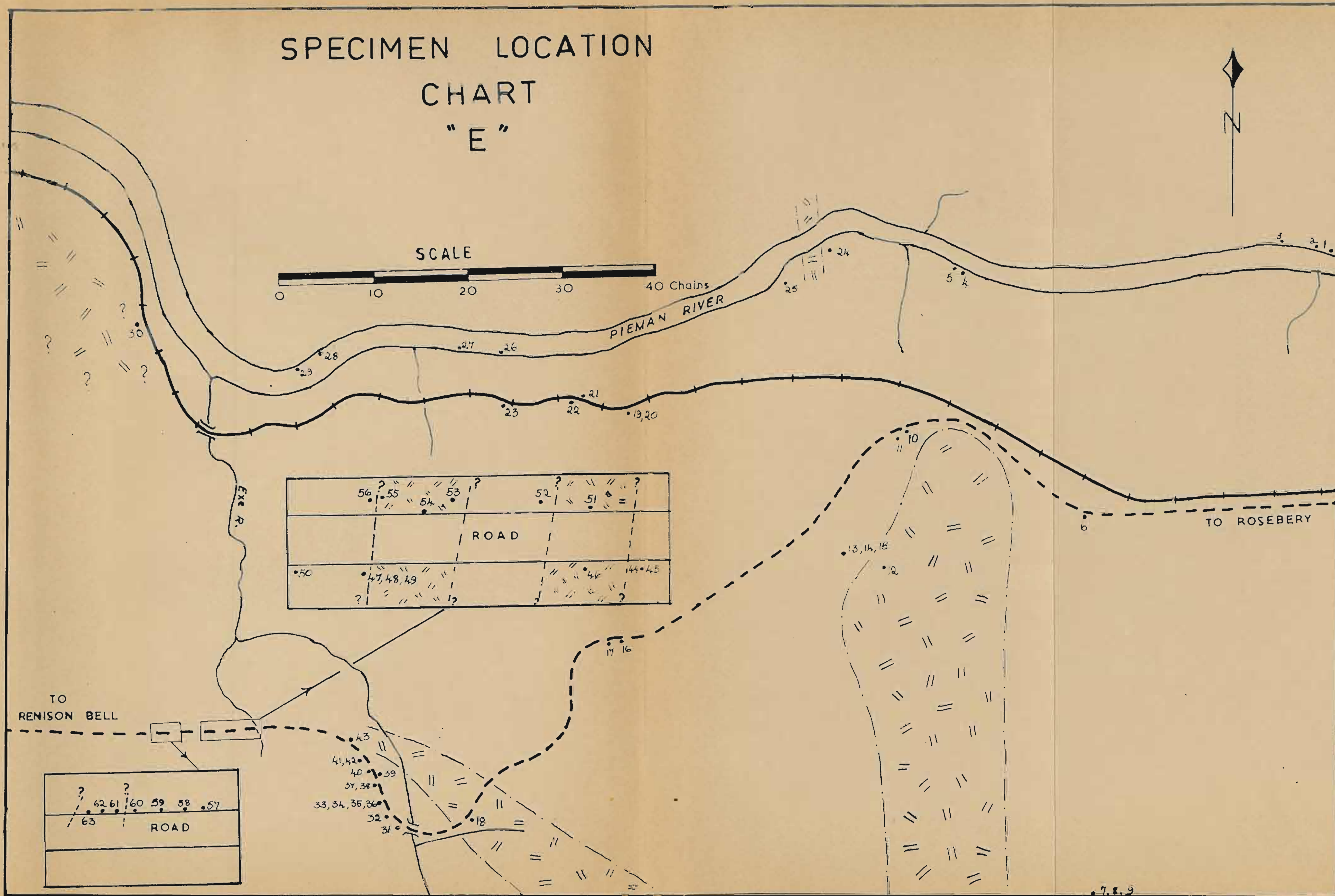
SPECIMEN LOCALITY CHART "C"

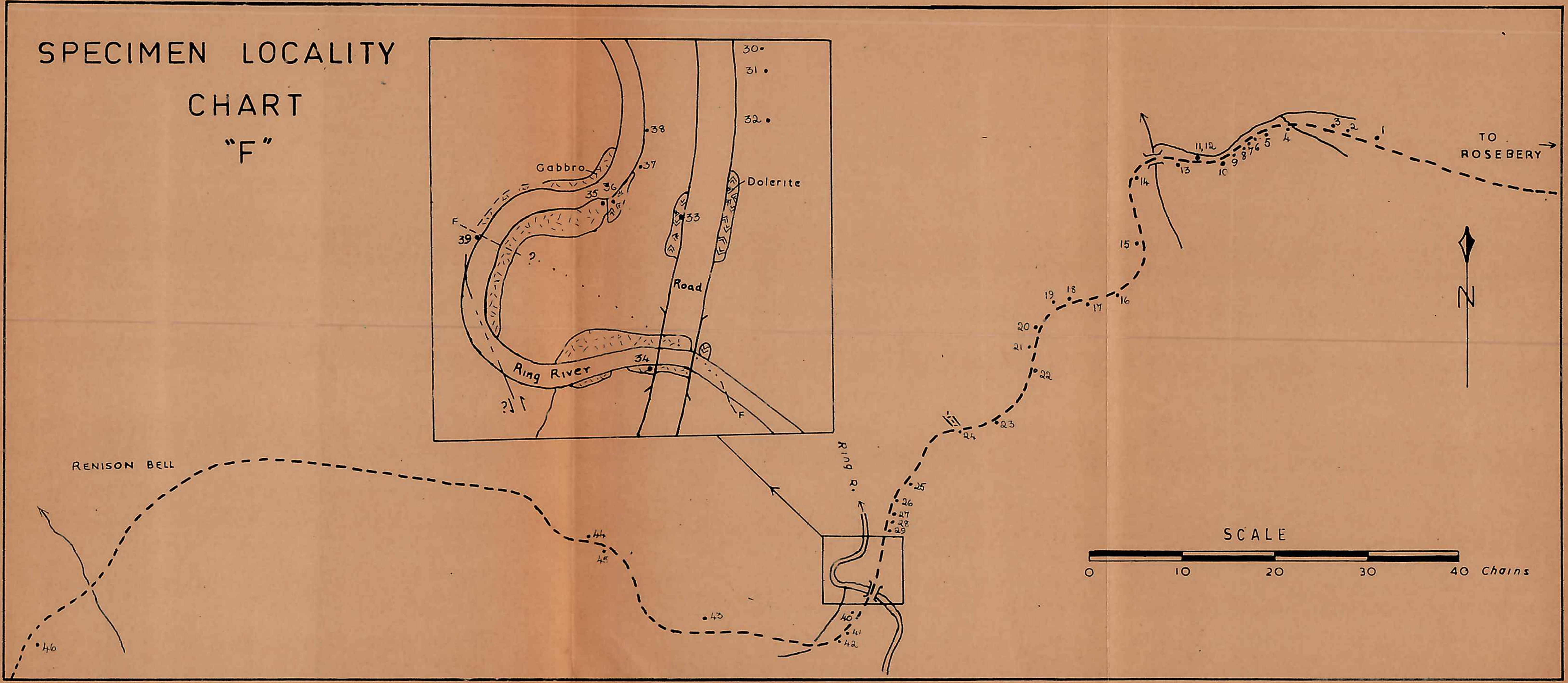




SPECIMEN LOCALITY CHART "D"

SPECIMEN LOCATION CHART "E"




SPECIMEN LOCALITY
CHART
"F"
Gabbro
Dolerite
Road
Ring River
Ring R.
RENISON BELL
TO ROSEBERY
SCALE
0 10 20 30 40 Chains
N

13.2 Departmental Slides

The following 109 slides from the collection of the Geology Department were examined in connection with this thesis. Some of these were useful, in that they represented rocks actually being studied. Although the location descriptions on many others were so inadequate as to make them practically useless for detailed work, they nevertheless represented generalised suites over more or less restricted areas, that were of interest for purposes of comparison and correlation.

The entire catalogue description of the slide consists of, (a) number; (b) rock type; and (c) locality. Where necessary an indication of the geology of the parent rock (inferred from the description, or the petrography, or both) is added in parenthesis. A single question mark in parenthesis indicates that the description on the slide appears to be incorrect.

The Departmental catalogue slides are at present grouped under different number-series. The slides examined are listed similarly. Much of this list will therefore retain its usefulness only if a record is kept when the slides are renumbered into the master catalogue.

61-6	Tremolitized gabbro	Confidence saddle.
61-9	Rhyolite	Natone Creek.
61-10	Do.	Do.
61-11	Sheared greywacke	Do.
61-12	Sheared porphyry	Do.
87	Serpentine	Half a mile south of Argent Tunnel.
88	Do.	Do.
89	Do.	Do.
596	Porphyroid	Mt. Read
597	Do.	Do.
598	Do.	Do.
599	Do.	Do.
600	Do.	Do.
601	Do.	Do.
602	Do.	Do.
603	Do.	Do.
604	Do.	White spur, Mt. Read.
605	Do.	Do.
606	Do.	Do.
607	Do.	Do.
608	Do.	Tipperary Creek.
609	Do.	Tyndall track.
610	Do.?	Do.
611	Do.?	Tyndall track, south of Mt. Read.

612	Schistose keratophyre?	Tyndall track, Henty.
613	Schistose keratophyre	White spur, Mt. Read.
614	Quartz porphyry	Mt. Black Mine.
615	Porphyroid	Upper adit, Mt. Black.
616	Silicified felspar porphyry	Shaft, Mt. Black Mine.
617	Porphyroid	Main adit, South Hercules.
618	Do.	South Hercules.
619	do.	Adit, East Hercules.
620	Calcareous rock	No. 2 adit, South Hercules.
621	Chlorite rock	East Hercules.
622	Calcite-quartz rock	No. 4 adit, Hercules.
623	Do.	Crown Hercules, Mt. Read.
624	Porphyroid	Rosebery Mine.
625	Actinolite rock	Colebrook Hill.
626	Actinolite schist	Colebrook Hill.
627	Diopside rock	Do.
628	Datolite rock	do.
629	Axinite rock	do.
630	Do.	do.
631	Bronzitite	New West Colebrook, Ringville.
632	Axinite (Limurite) rock	Colebrook Mine Ringville.
648	Porphyroid	Ring River P.A.

649	:	Porphyroid	:	Dinner Creek, North Dundas.
5001	:	Curtin Davis Volcanics:	:	Montezuma Falls.
5005	:	Do.	:	Do.
5006	:	do.	:	do.
5482	:	Metamorphic slate	:	Colebrook P.A., North East Dundas.
5486	:	Quartz micro-breccia	:	Dundas.
6894	:	Porphyroid	:	Mt. Black.
6895	:	Ferruginous sandstone	:	Misery Hill (Misery Conglomerate).
6896	:	Tuff?	:	Misery Hill, Dundas.
6898(i)	:	Basalt	:	Rosebery Mine (?).
6898(ii)	:	Do.	:	Do.
6902	:	Pyroxenite	:	Argent Tunnel.
6910	:	Quartz-albite rock	:	Argent Tunnel.
50 G 122	:	Olivine Basalt Melaphyre	:	Mouth No. 2 Tunnel, Commonwealth, North Dundas.
50 G 128	:	Actinolite rock	:	North boundary, Sect. 5094, North Dundas.
50 G 129	:	Actinolized slate	:	North boundary, Sect. 5094, North Dundas.
50 G 130	:	Do.	:	Do.

50 G 135 :	Qtz.-fels. porphyry :	12.50 ml. peg, North East Dundas Tram.
50 G 136 :	Greywacke :	13.79 ml. peg, North East Dundas Tram.
50 G 137 :	Dyke Gabbro :	Centre Sect. 712, North Dundas.
50 G 144 :	Intrusive rock (?) Felsite :	Carbine track, ¼ ml. south of N.E. Dundas Tram.
50 G 145 :	Do. :	North East Dundas Tram.
50 G 146 :	Quartz porphyry :	S.W. Curtin Davis Mine.
50 G 148 :	Do. :	N.E. Dundas Tram.
50 G 149 :	Do. :	S.W. Curtin Davis Mine.
50 G 150 :	Qtz.-fels. porphyry :	Do.
50 G 151 :	Quartz porphyry :	do.
50 G 152 :	Breccia :	do.
50 G 153 :	Inclusion in porphyry :	do.
50 G 154 :	Quartz porphyry :	do.
50 G 155 :	Do. :	do.
50 G 156 :	do. :	do.
50 G 157 :	do. :	do.
50 G 158 :	do. :	do.
50 G 161 :	Keratophyre :	End of No. 2 Tunnel, Hercules Mine.
50 G 162 :	Schistose keratophyre :	295 ft. from face, No. 2 tunnel, Hercules Mine.

50 G 163	:	Schistose keratophyre	:	66 ft. from face, No. 2 tunnel, Hercules Mine.
50 G 164	:	Do.	:	99ft. from face, Do.
50 G 164	:	do.	:	132 ft. from face, Do.
50 G 166	:	do.	:	165 ft. from face, do.
50 G 167	:	do.	:	198 ft. from face, dò.
50 G 169	:	Quartz porphyry	:	Carbine track, S.W. Curtin Davis Mine.
50 G 172	:	Do.	:	Old Carbine section, North Dundas.
31288	:	Paraconglomerate	:	Misery Hill: (Misery Conglomerate)
31289	:	Siltstone	:	Misery Hill: (Clime formation?)
31290	:	Paraconglomerate	:	Brewery Junction, Dundas: (Brewery Junction Formation).
31291	:	Slate (?)	:	Do.
31292	:	Slate	:	Hodge Mine, Dundas: (Hodge Slat
31293	:	Slate	:	North East Dundas Tram.
31294	:	Oolitic chert (?)	:	Renison Bell.
31295	:	Fuchsitic paragonclomerate	:	"Rosebery Series", west of Rosebery.
31296	:	Slate (?)	:	Rosebery Mine: (Host rock).
31297	:	Volcanic breccia	:	Rosebery.
31298	:	Dacite	:	Rosebery.
31299	:	Serpentinite	:	Renison Bell.

31772	:	Mt. Read Volcanics	:	Rosebery : (Host rock?)
31773	:	do.	:	do.
31781	:	do.	:	do.
31775(i)	:	do.	:	do.
31775(ii)	:	do.	:	do.
31774	:	Quartz-sericite schist	:	do.
31775	:	Mount Read Volcanics	:	do.
31776	:	do.	:	do.

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